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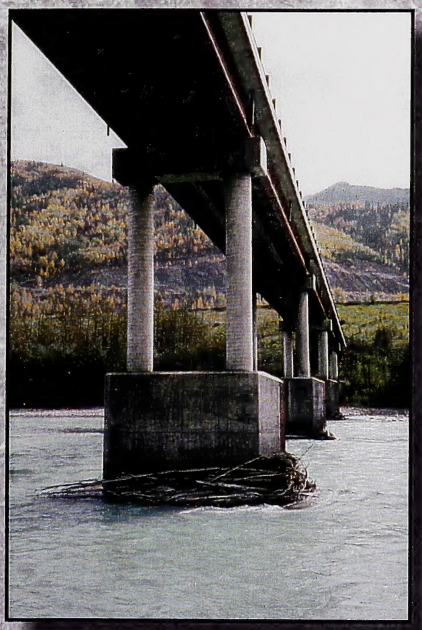
SMOKY RIVER COAL FLOOD RISK MAPPING STUDY



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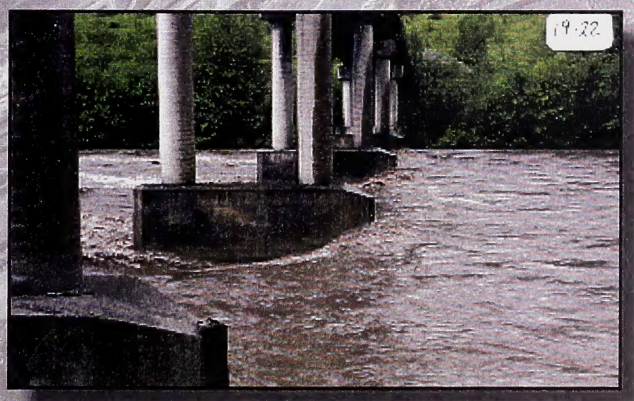

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Hydroconsult

June 2004

File: 857

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SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

June 2004

Prepared for:
Alberta Environment

Hydroconsult

File:857

ACKNOWLEDGEMENTS

This study was directed and managed by Ms. Pat Stevenson of the River Engineering Branch who defined the project criteria and scope, and compiled and supplied the data. The impetus to get the study going and completed was provided by Mr. Dave Henderson and by Mr. Geoff Foy, Alberta Environment.

Other data and information was provided by Mr Chris Quintillio and Mr. Bill Capstick of Smoky River Environmental Services, Mr Merle Cropley of Grande Cache Coal Corporation, Mr. Owen Terry (former SRC employee), Mr. Peter Armstrong (retired) and the Historical Society of Grande Cache.

The study was conducted by Mr. Dave Cooper and Mr. Andy Wong with drafting /mapping provided by Mr. Gary Evenson, all of Hydroconsult.

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1.0 INTRODUCTION

1.1 Flood Damage Reduction Program

The Canada-Alberta Flood Damage Reduction Program (FDRP) was initiated based on "An Agreement Respecting Flood Damage Reduction and Flood Risk Mapping in Alberta", signed by the Federal Government of Canada and the Provincial Government of Alberta in 1989. This program is designed to encourage non-structural methods of flood damage reduction by identifying areas subject to flooding and by promoting the application of appropriate land use planning, zoning, flood proofing and flood preparedness to avert the potential losses of life and property in these flood prone areas.

The FDRP includes the following components, as defined by Alberta Environment (1990):

1. Identify, map and designate flood risk areas in communities across the province;
2. Increase awareness of flood risk among the general public, industry and government agencies through a public information program;
3. Regulate new development in these flood risk areas using new federal and provincial government policies; and
4. Encourage municipalities to develop zoning bylaws recognizing the designated flood risk areas.

1.2 Study Objectives

The purpose of this study is to delineate the flood risk and floodway limits of the 1:100 year design flood event along a reach of the Smoky River in the vicinity of the former Smoky River Coal (SRC) plant. The existence of the former mining-related infrastructure located within the floodplain of the Smoky River poses ongoing concerns since Alberta Environment has assumed responsibility for the former mine and plant site areas since closure in 2000. It is intended that the designation of flood fringe and floodway zones as presented herein will form the basis of future floodplain management, and assist in reclamation or any subsequent development planning at the former plant site.

1.3 Study Area

The former Smoky River Coal plant site is located approximately 20 km north of the Town of Grande Cache in west central Alberta, as shown in Figure 1. The study area encompasses a 5 km reach of the Smoky River from just upstream of the confluence with the Muskeg River to upstream of the plant site area. The study area includes the following facilities in the Smoky River valley:

- the former Smoky River Coal plant including a multi-cell settling pond facility adjacent to the river bank;

- the operating H. R. Milner power plant on the left (north) bank immediately downstream of the coal plant area with related buildings, water management ponds releasing to a downstream wetland area and a water intake and pumphouse on the river;

- a RailNet railway line with multiple lines and loading facilities located between the plant site areas and the river with an office/maintenance building on the river side of the rail lines;

- two bridge crossings including a three pier conveyor/pipeline bridge that is in danger of collapse and we understand is planned to be removed in the near future, and a six-pier road bridge; and

- a multi-cell tailings pond facility extending for over 1 km along the right (south) overbank area.

2.0 HISTORY OF FLOODING

2.1 General

The Smoky River headwaters originate high in the Rocky Mountains along the continental divide, northwest of Jasper National Park. The river flows north to drain an area of 3,840 km² at the Water Survey of Canada (WSC) streamflow gauging station – Smoky River above Hells Creek (Station No. 07GA001). This station is located 7 km upstream of the upstream limit of the study area. Flood flows are expected to be nearly equal at the two locations because of the minor increase in drainage area between the gauging station and the study area. As a large river originating well within the Rocky Mountains, extreme flood events occur as a result of large summer rainfall events from cold-low frontal systems moving upslope and stalling against the mountains.

2.2 Historic Floods

The WSC station above Hells Creek has operated since 1968 recording 36 annual maximum daily discharge values to 2003. Maximum instantaneous discharge values are reported for 33 of those years. The largest flood on record at the WSC station above Hells Creek was a maximum instantaneous discharge of 1380 m³/s on June 12, 1972 and a maximum daily value of 1230 m³/s. This flood occurred as a result of a major rainfall mostly occurring within a 24-hour period. Storm isohyetal mapping indicate the maximum rainfall at over 200 mm was centered northwest of the Smoky River in the Cutbank and Wapiti River basins. More extensive flooding and damage was reported downstream of the study area on the Smoky River below the Sheep Creek confluence (Alberta Environment, 1972).

The largest recorded floods are summarized in Table 1.

Table 1: Maximum Recorded Flows at Smoky River Station 07GA001 (1968-2003)

Date	Maximum Instantaneous Discharge (m³/s)	Maximum Daily Discharge (m³/s)
June 12, 1972	1380	1230
July 13, 1997	1012	948
July 18, 2001	811	661

All of the above events occurred as a result of rainfall. The two lower events were a result of an extended period of rainfall over several days.

2.3 Ice Jam Floods

Flooding as a result of ice jams may be significant at the site. However, no record of major ice events have been noted from conversations with long-term personnel based at the former mine

(pc Merle Cropley, SRC employee 1977-2000). Ice jam floods are not a part of this study scope and are assumed to be lower than extreme open water flood levels.

3.0 AVAILABLE DATA

3.1 Hydrology Report

A hydrology study of the Smoky River at the former plant site was undertaken by the Hydrology Branch, Surface Water Section of Alberta Environment in 2002 to determine flood discharge estimates for selected return periods. Table 2 summarizes the resulting flood frequency estimates adopted for this study (Alberta Environment, 2002).

Table 2 Smoky River at Former Smoky River Coal Plant Site Flood Frequency Estimates

Return Period (years)	Maximum Instantaneous Discharge (m^3/s)	Maximum Daily Discharge (m^3/s)
2	428	399
5	580	539
10	712	658
20	864	795
50	1100	1010
100	1320	1200

3.2 Base Mapping and Cross Section Surveys

Mapping for this study consisted of the digital elevation model (DEM) for the area from the SRC database, as supplied by Alberta Environment. The base photography used for the mapping was originally done in the early 1970's and updated in the plant site area in 1984. The mapping was prepared at a scale of 1 inch to 100 feet (1:1200) with a contour interval of 10 feet. The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.

Alberta Environment commissioned a survey of 14 cross-sections of the river (numbered 1 to 14, located as shown in Figure 2). Vertical datum is geodetic (NAVD29). Horizontal datum is NAD83. The cross-sections are plotted in Appendix C along with site photos.

Bridge section and pier data were obtained from the original design drawings prepared by Kilborn Engineering for McIntyre Porcupine Mines Ltd. (Project No. 306, March to December, 1969) and supplied by Grande Cache Coal for this study.

3.3 High Water Mark Data

The term "high water mark" refers to evidence remaining after a high water event (i.e. strand lines formed by debris, silt lines on vegetation or structures) which denotes the maximum water level.

A high water mark was surveyed along the right bank adjacent to the plant site settling pond cells by Hydroconsult following the July 18, 2001 flood. This survey was tied to the top of the concrete on the pond outlet structure which had an assumed elevation from previous surveys conducted for SRC. A level check survey between the level of the concrete and the left bank pin on cross-section 9 conducted by Smoky River Environmental Services in February 2004 indicated

that the 2001 high water elevation at section 9 is 916.64 m. A photo during the 2001 flood is provided in Appendix C.

River water levels and slopes adjacent to the settling pond cells were surveyed by Hydroconsult on two other dates – May 23, 2001 at a discharge of 83 m^3/s and on August 6, 1999 at a discharge of 198 m^3/s.

Other observations or anecdotal data from the historic floods in 1972 and 1997 are discussed below.

Observations by plant site personnel at the time of the 1972 flood event indicate that the water level peaked at about "2 feet below the railway grade" (p.c. Peter Armstrong, former Kilborn Engineering employee on site at the time of the event). The railway grade elevation at the SRC plant site ranges from 920.9 m upstream at section 11 to 917.9 m downstream at section 9. This suggests the high water level during the 1972 flood may have ranged from 920.3 m to 917.3 m through the plant site area.

There are no records of river levels during the 1997 flood within the study area other than former personnel at the plant site indicating that the level did not overtop the bank (p.c. Owen Terry, former SRC Senior Environmental Technologist, 1990-1999).

3.4 Rating Curves

A rating curve was constructed at section 9 based upon the water level surveys and anecdotal information discussed in section 3.3. Although not within the study area, spot flow measurements and the rating curve at the WSC station located a few kilometers upstream were used to compute Manning's roughness coefficients at this location. The computed Manning's value for flow measurements from 125 to 140 m^3/s was 0.032.

3.5 Flood Photography

Aerial photographs taken August 11 1952, May 1995 (SRC orthophoto) and August 26 1997, various ground photographs and photographs at each of the surveyed river cross-sections were used as an aid to estimate Manning's roughness coefficients for overbank flows and to estimate bank locations for hydraulic modeling purposes (Appendix C).

Historical flood and site photos collected from various sources are provided in Appendix A. These assisted with calibration of the model.

4.0 RIVER/VALLEY FEATURES

4.1 General Description

The Smoky River flows northeast through a deep stream cut valley in the study area. The narrow valley flat is fragmented with old meander scars and former channels some of which have become wetland areas. Vegetation in the floodplain areas range from heavily treed to light brush/shrub and cleared areas. Historical air photo overlay comparisons from 1952 to 1997 (Terrace Engineering Ltd., 2003) show the lateral instability of the river, particularly in the lower portion of the study reach.

4.2 Channel Characteristics

The channel has irregular meanders with occasional islands, and mid-channel and point bars. The channel width ranges from 85 to 250 m and averages 137 m in width within a valley bottom from 225 to 475 m wide. The channel is laterally more active in the lower reach upstream of the Muskeg River confluence and is a more confined, single channel in the upper portion of the study reach. Substrate consists of primarily gravel to cobble with silt and sand deposits common. The high gradient river with an average slope of 0.21% has a heavy sand /silt transport load.

4.3 Floodplain Characteristics

The floodplain is limited in the narrow valley to former channel locations and ranges in width from negligible to about 400 m. The former SRC plant site on the left side of the valley is located on a former terrace or old channel meander. A large wetland area downstream of the H. R. Milner plan is isolated from the river by the rail line. Any right side floodplain areas tend to be very limited in extent with higher sloping ground on the right and generally dense, mature treed vegetation.

4.4 Man-Made Features

Features constructed in the river and floodplain in addition to the two bridges and other feature previously described include:

- the railway located along the left floodplain which isolates a former meander channel (now a wetland) in the lower reach;
- class II to III riprap protecting the left bank in the vicinity of the SRC plant site and the settling pond cells;
- a lift station pumphouse on the right bank just downstream of the conveyor bridge; and
- a raw water intake pumphouse excavated into the left bank.

5.0 CALCULATION OF FLOOD LEVELS

5.1 HEC-RAS Program

The FDRP has adopted the 1:100 year return period flood as the hydrological event for which the flood risk area is to be determined. The 1:100 year water surface profiles for this study were computed using the HEC-RAS program (Version 3.01, May 2002) developed by the Hydrologic Engineering Centre of the U.S. Army Corps of Engineers. This program was designed to calculate water surface profiles for steady, gradually varied flows in natural or constructed channels. Specific capabilities include (i) the calculation of subcritical flow (normal flow in natural channels) and supercritical flow profiles, (ii) modelling the effects of obstructions and structures such as bridges, culverts and weirs, and (iii) assessment of the effects of changes to the channel, such as encroachments, channelization and levees or dykes. The program is based on the solution of the one-dimensional energy equation. Energy loss due to friction is calculated using Manning's

equation. The computational procedure is an iterative technique using the standard step method, which is a finite difference solution of the energy equation.

The model is limited by the following assumptions on which it is based:

1. One-dimensional flow is assumed, which may be applicable to sudden changes, such as expansions or contractions, where flow may become two and three-dimensional.

2. Flow is assumed to be steady.

3. Channel bed and banks are assumed to be rigid, as opposed to mobile and eroding, especially during flood conditions.

4. Uniform hydrostatic pressure is assumed to exist across the whole cross-section; therefore the effects of superelevation cannot be simulated.

5. The total energy head is assumed to be the same across the entire cross-section without considering the energy exchange between the flows within the channel and in the floodplain.

6. The river channel gradient is assumed to be small, that is, less than 0.1.

5.2 Geometric Data Base

Geometric data needed for the HEC-RAS model include river cross-sections and geometric descriptions of structures within the flood risk area, such as bridges and culverts.

5.2.1 Cross-Sectional Data

River cross-sections are needed to define the hydraulic characteristics of the river in the HEC-RAS model. A total of 14 cross-sections were used to describe the Smoky River through the study area. The location of these cross-sections are displayed on the Flood Risk and Flood Frequency maps located at the back of this report.

5.2.2 Bridges

The road and conveyor bridges are the two bridges within the study area. Because (i) the superstructures of both bridges were at or above the estimated 1:100 year flood levels and (ii) the bridges do not experience significant pressure flow or weir flow during the modelled floods, these bridges were modelled using the normal bridge options in HEC-RAS.

5.3 Hydraulic Parameters

5.3.1 Expansion Contraction Coefficients

In the conveyance of water in a channel, energy is lost by various factors. One type of energy loss is called transition loss and is associated with changes in the geometry of the watercourse cross-sections and therefore, changes in velocity head. In the HEC-RAS model, these losses are expressed as the product of the absolute difference in velocity heads between adjacent cross-

sections and a coefficient. If the velocity head decreases downstream (i.e., if the area of the downstream cross-section is larger that that of the upstream cross-section), the coefficient is termed an expansion coefficient. If the velocity head increases downstream (i.e., if the area of the downstream cross-section is smaller than that of the upstream cross-section), the coefficient is termed a contraction coefficient. Generally, the expansion loss is greater than the contraction loss and an abrupt transition has a greater loss than a gradual transition. The values for the expansion and contraction coefficients can range from 0.0, representing no transition loss, to 1.0, representing maximum transitional loss.

In calibrating the model the adopted expansion and contraction coefficients were 0.3 and 0.1, respectively, for reaches with little change. These were applied throughout the Smoky River study reach.

5.3.2 Manning's Roughness

Another type of energy loss is due to friction at the interface of water and the bed and banks of the channel. In a simplified model, many types of losses are lumped into one and described by a single coefficient. In the HEC-RAS model, the losses due to friction are computed using the widely known and accepted Manning's equation. The Manning's roughness coefficient, denoted by 'n', is the only variable input parameter of Manning's equation, once discharge and cross-sectional geometry is established. This roughness coefficient can be highly variable, ranging from 0.010 for concrete lined channels to 0.150 and greater for thickly vegetated channels and overbanks. The value of a Manning's roughness coefficient takes into account such diverse factors as types of bed and bank material, vegetation, channel irregularity, obstructions, cross-sectional shape, stage, and discharge. Proper calibration of the HEC-RAS model is very much dependent upon the accurate estimation of values for Manning's n.

5.4 Model Calibration

5.4.1 Methodology

To determine the extent of inundation during a 1:100 year flood using the HEC-RAS model, the value of Manning's roughness must be determined to properly calibrate the model.

Given the geometry, discharge and stage of a river, it is possible to accurately estimate the Manning's roughness coefficient. The methodology used to calibrate the HEC-RAS model in this study involved attempts to replicate measured high water marks for an associated discharge by adjusting, within acceptable limits and through an iterative process, estimates of Manning's n coefficients. These 'best estimates' were then used in the calibrated HEC-RAS model to determine the water levels for selected design discharges. Overbank roughness values were assigned using typical values quoted in the literature for various types of floodplain conditions ranging from short grass to heavy bush (Reference 4). Manning's n values of 0.07 to 0.08 were applied for brush /shrub vegetated bars and values of 0.075 to 0.10 were applied for the floodplain areas where the depth of flow was typically much less than 1 m.

5.4.2 Results

Calibration results for the surveyed high water mark data at the 2001 peak and lower discharges and comparisons with the anecdotal information for the other flood events are provided in Table 3 and illustrated in Figure 3.

Table 3: Smoky River Calibration Results at SRC Plant Site

Location / Event Description	Cross-Section No.	High Water Mark Information/ Data (m)	HEC-RAS Simulation (m)	Difference (HEC-RAS – HWM Data) (m)
1972 Peak (1,380 m³/s) – 0.6 m below railway grade at SRC plant	9	917.28	917.47	+0.19
	10	918.90	918.90	0.00
	11	920.31	919.66	-0.65
1997 Peak (1,012 m³/s) at or below top of bank at SRC plant	9	916.84	916.97	+0.13
	10	918.74	918.22	-0.52
	11	919.84	918.98	-0.86
2001 Peak (810 m³/s)*	9	916.66	916.64	-0.02
U/S settling pond outlet*	8-9	916.36	916.08	-0.28
July 27, 2001 (217 m³/s)*	9	915.06	915.05	-0.01
Aug 6, 1999 (198 m³/s)*	9	914.97	914.97	0.00
May 23, 2001 (83.3 m³/s)*	9	914.37	914.33	-0.04

* based upon surveyed water levels, others are anecdotal estimates only.

The 2001 surveyed water level at section 9 is used as the main data point for calibration and results in a moderately high main channel roughness value of 0.044. At the lower discharges the calibration still matches quite well such as for the July 27, 2001 water level shown in Figure 3.

Figure 3 shows that the simulated 1972 peak level is consistent with the observed water level at section 10 in the middle of the SRC plant site area. Figure 3 also shows the 1997 peak water level profile is below the top of the left bank through the SRC plant area and starts to exceed the top of bank at the settling ponds downstream of section 9.

The proportion of overbank flow is relatively minor (less than 16 %) and therefore resulting water levels are relatively insensitive to variations in the assumed overbank roughness values.

5.5 Model Sensitivity

5.5.1 Initial Starting Conditions

The starting water elevations at cross-section 1, the most downstream section of the study reach, were determined using the normal depth calculation method option and inputting an average downstream channel slope of 0.002. This is the average slope in the surveyed reach. The effect of this assumption is minor and any minor error would be eliminated within a short distance of the next cross-section by the step calculation procedure in the program.

A sensitivity analysis performed on the starting water level computations by changing the input assumptions as follows:

- normal depth computation assuming a starting slope of 0.001;
- normal depth computation assuming a starting slope of 0.0035; and
- starting at the critical depth.

The differences in the starting water levels for each of the above conditions at the 1:100 year discharge, from the selected value were as follows:

- 0.89 m higher assuming a starting slope of 0.001;
- 0.65 m lower assuming a starting slope of 0.0035; and
- 1.9 m lower at the critical depth.

The convergence distance (the distance where the difference in computed water level is 1 cm or less between the two profiles) for the resulting 1:100 year water surface profiles for these methods are summarized in Table 4.

Table 4: Smoky River Starting Elevation Sensitivity Analysis

Method	Corresponding Starting Elevation (m)	Convergence Distance (m)	Convergence occurs downstream of Section No.
Normal depth with starting slope at 0.002	910.63	-	-
Normal depth with starting slope at 0.001	911.52	2120	7
Normal depth with starting slope at 0.0035	909.99	1820	6
Critical Depth	908.73	1820	6

5.5.2 Manning's Roughness

A sensitivity analysis was performed on the channel Manning's roughness coefficients to determined the degree to which the water surface profiles may be influenced by the choice of values. Comparisons were made with the 1:100 year calculated or base run water surface profile. Variations of ±10, 20 and 30% in both channel and floodplain Manning's values from the base run are summarized in Figure 4. The average differences over the study reach are summarized in Table 5. The maximum variation occurs at section 13 ranging from about plus 0.7 m at +30% to minus 0.9 m at –30%.

Table 5: Manning's Roughness Sensitivity Analysis

	Manning's Roughness Variation from Base Run					
	-30%	-20%	-10%	+10%	+20%	+30%
Average Difference from Base Run (m)	-0.69	-0.45	-0.22	+0.20	+0.39	+0.58

5.6 Computed Water Surface Profiles

The results of the calibrated model and the sensitivity analyses suggest that the calibrated HEC-RAS model can produce reasonable water surface profile estimates of flood events along the Smoky River through the study reach. As such, water surface profiles were generated for floods with 1:50 and 1:100 year return periods at the discharges presented in Table 2. The resulting water surface profiles for these two flood events are presented in Figure 5 along with the minimum bed elevation and cross section number for reference. Table 6 numerically presents the computed water surface elevations for the two flood events at each section. Table 6 also includes the resulting water levels assuming the conveyor bridge is removed. This comparison shows that

the increase in water level due to the conveyor bridge is only local and less than 1 cm at the 100 year flood level.

The average channel velocity through the study area at the 1:100 year discharge is 2.64 m/s ranging from 1.94 m/s at section 6 to 3.61 m/s at section 9.

Table 6: Smoky River Water Surface Elevations (m) for Existing Conditions and with Conveyor Bridge Removed

Cross Section	Cumulative Distance (m)	Existing Conditions		Conveyor Bridge Removed	
		50 Year Flood	100 Year Flood	50 Year Flood	100 Year Flood
1	0	910.20	910.63	910.20	910.63
2	300	910.83	911.27	910.83	911.27
3	610	911.44	911.87	911.44	911.87
4	1279	912.51	912.89	912.51	912.89
5	1656	913.18	913.51	913.18	913.51
6	1978	913.96	914.26	913.96	914.26
7	2391	914.94	915.24	914.94	915.24
8	2886	916.12	916.41	916.12	916.41
9	3235	917.10	917.39	917.10	917.39
10 d/s	3617	918.36	918.76	918.36	918.76
10 u/s	3633	918.40	918.80	918.39	918.79
11	4097	919.16	919.56	919.16	919.56
11.1 d/s	4107	919.19	919.59	919.18	919.59
11.3 u/s	4113.5	919.25	919.68	919.25	919.67
12	4439	919.96	920.40	919.96	920.40
13	4804	920.85	921.31	920.85	921.31
14	5117	921.63	922.15	921.63	922.15

5.7 Flood Frequency Maps

Flood frequency mapping delineated on the 1:5000 scale base map for the 50 and 100 year floods are shown in Figures 6.1, 6.2 and 6.3. These maps show the area flooded under natural conditions for these events with minor differences between the 50 and 100 year events. The HEC-RAS model input and output data for the calibration, 50 year and 100 year flood events are provided in Appendix A.

6.0 FLOODWAY DETERMINATION

6.1 Terminology

The following terms were defined by Alberta Environment in two publications: "Hydraulic Guidelines for Floodplain Delineation" in 1990 (Ref. 1), and "Canada-Alberta Flood Damage Reduction Program" (undated brochure).

Flood Risk Area
Under the Flood Damage Reduction Program, the flood risk area is defined as the area which would be inundated by the 1:100 year design flood. Within a flood risk area, a distinction is made between the floodway and the flood fringe areas.

Floodway
The floodway is defined as the stream channel and that portion of the floodplain required to convey the 1:100 year design flood under constricted conditions, assuming no conveyance capacity in the flood fringe. Floodway waters are deepest, fastest, and most destructive; new development in these areas is discouraged.

Flood Fringe
The flood fringe is that portion of the floodplain between the floodway and the outer boundary of the 1:100 year design flood. Development in the flood fringe may be permitted provided that it is adequately flood proofed.

6.2 Floodway Criteria

According to Alberta Environment's 1990 Guidelines, the following geomorphic and hydraulic criteria define the floodway limits.

1. Since the floodway is usually narrower than the total flood risk area, the water surface elevation must increase to carry the same discharge. The water surface levels, due to the floodway constriction, shall not exceed 0.3 m above the levels of the design flood without the constriction.

2. In general, all areas where the depth of flooding exceeds 1 m or the velocities exceed 1 m/s, are considered part of the floodway. However, to achieve a hydraulically smooth floodway boundary, some areas with depths exceeding 1 m and velocities exceeding 1 m/s may be included as part of the flood fringe.

3. In river reaches where the existing mean channel velocities are excessive, the encroachments of the floodway should be minimized so that the existing velocities are not increased further.

6.3 Methodology

Detailed procedures for floodway determination, as applied in this study, are outlined below.

1. The flow distribution option in the HEC-RAS model was activated to calculate the 1:100 year design flood velocity and depth distribution at all cross-sections.

2. Floodway boundaries were initially approximated by selecting the 1.0 m depth isoline or the 1 m/s velocity location, whichever was the least constrictive.

3. All cross sections were then checked with the encroachments in place to ensure that the 0.3 m incremental increase in water level, the 1 m/s velocity, and the 1 metre depth were not exceeded.

4. The floodway boundaries were then smoothed in specific areas to create a hydraulically smooth floodway.

6.4 Results

Table 7 summarizes the computed water surface elevations at each section for the 1:100 year discharge with and without floodway constrictions and shows which criteria were applied to determine the floodway boundary for each overbank.

Table 7 Criteria Governing Floodway Limits

Section	1:100 Year Flood Water Surface Elevation (m)		Water Level Increase due to Encroachment (m)	Controlling Criteria for Locating Left Bank Floodway Limit				Controlling Criteria for Locating Right Bank Floodway Limit			
	No Encroachment	With Encroachment		1.0 m depth	Main Channel	0.3 m Rise	Smooth	1.0 m depth	Main Channel	0.3 m Rise	Smooth
1	910.63	910.63	0.00		✔			✔			
2	911.27	911.27	0.00		✔			✔			
3	911.87	911.87	0.00	✔				✔			
4	912.89	912.89	0.00	✔				✔			
5	913.51	913.51	0.00	✔				✔			
6	914.26	914.26	0.00		✔				✔		
7	915.24	915.24	0.00	✔					✔		
8	916.41	916.41	0.00	✔					✔		
9	917.39	917.40	0.01		✔				✔		
10 d/s	918.76	918.88	0.12	✔				✔			
10 u/s	918.80	918.91	0.11	✔				✔			
11	919.56	919.61	0.05		✔			✔			
11 d/s	919.59	919.64	0.05		✔			✔			
11 u/s	919.68	919.72	0.04		✔			✔			
12	920.40	920.42	0.02		✔			✔			
13	921.31	921.32	0.01		✔			✔			
14	922.15	922.16	0.01	✔				✔			

As can be seen from Table 7, the locations of the floodway limits were all determined by the "1 m depth" criterion or by the "main channel". The main channel is not a defined criterion itself. However, further encroachment would violate one or more of the defined criteria.

The "0.3 m rise" criterion was not applied in any location. Computed water level increases were minor with the greatest computed rise of 0.12 m occurring locally at the conveyor bridge section. The close spacing of the sections meant the no smoothing was actually required for this study. The 1 m/s velocity criterion is not displayed in Table 7 because it was never a controlling criterion.

7.0 FLOOD RISK MAPS

7.1 General

The final 1:100 encroached-to-floodway water surface profiles were plotted on the 1:5000 contour map base for the study area in order to define the floodway and flood fringe areas. These flood risk maps are shown in Figures 7.1, 7.2 and 7.3. Model input and output data for the flood risk mapping are provided in Appendix B.

7.2 Areas Affected by the Floodway.

The floodway essentially extends close to the full extent of the flood fringe in many locations and frequently coincides with the channel top of the bank. The only facilities within the floodway appear to be the water intake pumphouse buildings and the adjacent power sub-station. However, this is due to a smoothing of the floodway line between sections 9 and 10. The ground level at these facilities are just slightly below the 1:100 year flood level.

7.3 Areas Affected by the Flood Fringe

The rail line on the left generally forms the limit of the flood fringe on this side of the river. At the downstream and upstream ends of the study area (sections 1, 2, 13 and 14), the railway grade is just at the 1:100 year flood level. The railway grade extends to near 1 m and more above the 1:100 year flood level between these sections. The water depth on the ditch or isolated wetland areas on the left side of the rail line may be more than 1 m but these are isolated zones with no flow velocity.

The main area of potential concern that is within the flood fringe, defined as between the floodway limit and the flood risk limit, are at the SRC plant settling pond cells. This area is the only sizeable area in the study reach that is in the flood fringe. This area can be sub-divided into two zones based upon the average depth and velocity computed at section 9. The first zone from the top of the river bank to about 30 m back has an average depth of about 0.7 m and an average velocity of 0.7 m/s. The remaining 90 m wide section back to the rail line averages about 0.45 m deep with an average velocity less than 0.5 m/s.

The access road along the right side of the river is well above the 1:100 year flood level. The base map contours downstream of the conveyor bridge at the access road show a low area. This is either an error in the base map or the area was filled in after the mapping was prepared. The floodway and floodplain mapping is drawn along the edge of the road here to reflect current ground contours.

REFERENCES

1. Alberta Environment, Revised November 1990. "Hydrologic and Hydraulic Guidelines for Floodplain Delineation", Flood Damage Reduction Program, Publication No. 1.

2. Alberta Environment, March 2002, "Smoky River near Grande Cache Flood Frequency Analysis", prep. By M. Seneka,P. Eng., Hydrology Branch, prep. for River Engineering Branch, Environmental Operations Division.

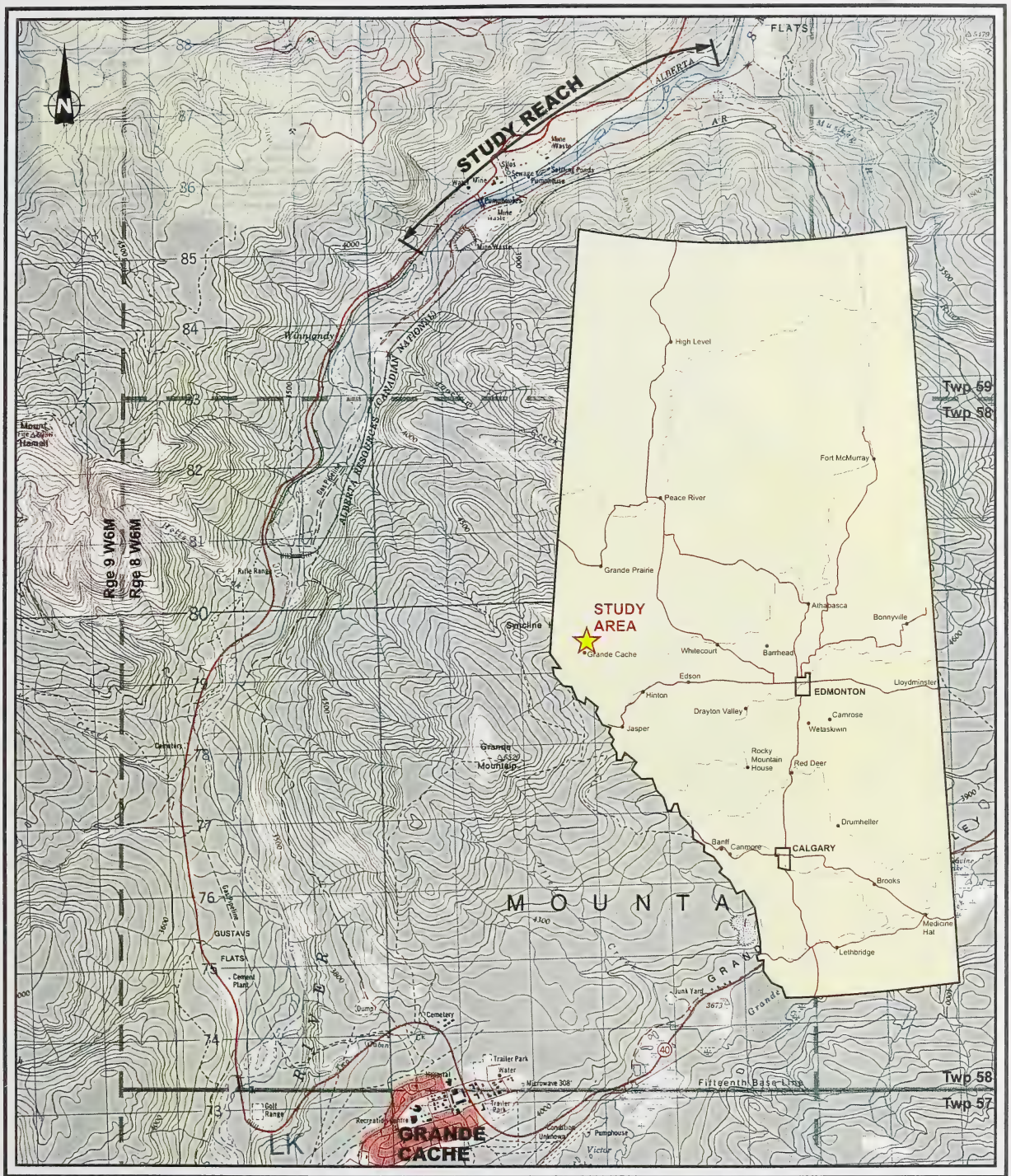
3. Alberta Environment, Undated Brochure. "Canada-Alberta Flood Damage Reduction Program", a published brochure.

4. Chow, V. T. 1959. "Open Channel Hydraulics", McGraw Hill Book Company.

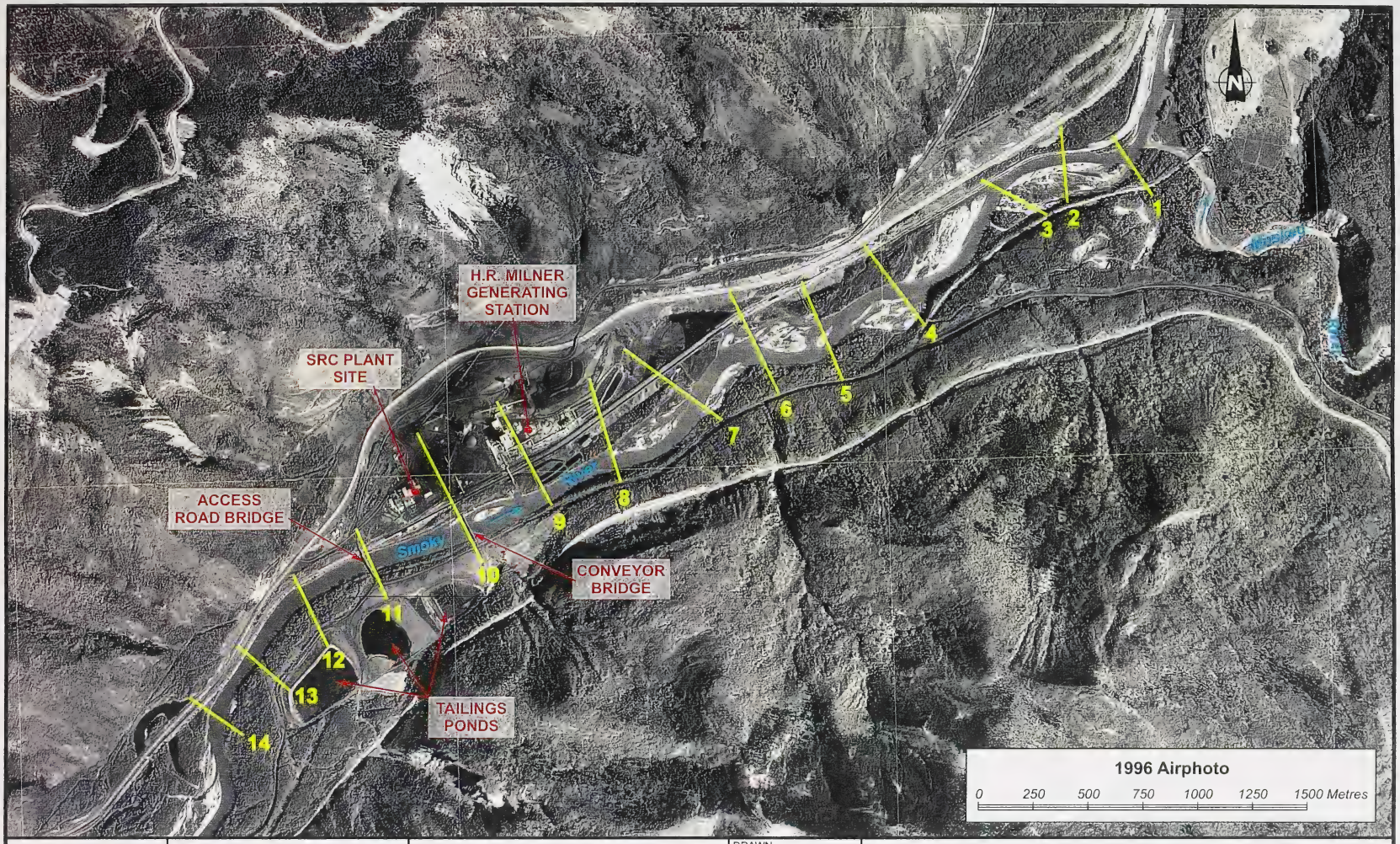
5. Terrace Engineering Ltd., 2003. "Conveyor / Pipeline Bridge over Smoky River at Former Smoky River Coals Plant North of Grande Cache – Hydrotechnical Assessment Report", prep. for Alberta Environment.

6. United States Army Corps of Engineers, May 2002. "HEC-RAS River Analysis System" Version 3.0. Hydrologic Engineering Centre. Davis, CA., CPD-68.

7. Water Survey of Canada, Environment Canada, 2003. HYDAT CD-ROM data and sample flow measurement data at Station 07GA001, Smoky River above Hells Creek.



Hydroconsult / Alberta Environment	DRAWN: Gary Evenson	SMOKY RIVER COAL FLOOD RISK MAPPING STUDY			
	DESIGN: Andy Wong	STUDY LOCATION MAP			
	APP: Dave Cooper				
	SCALE: 1 : 75 000				
	DATE: 04/03/08	FILE (CDR): 857-04-03-08-A2	JOB NO.: 857	FIGURE 1	



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DESIGN	Andy Wong
APP	Dave Cooper
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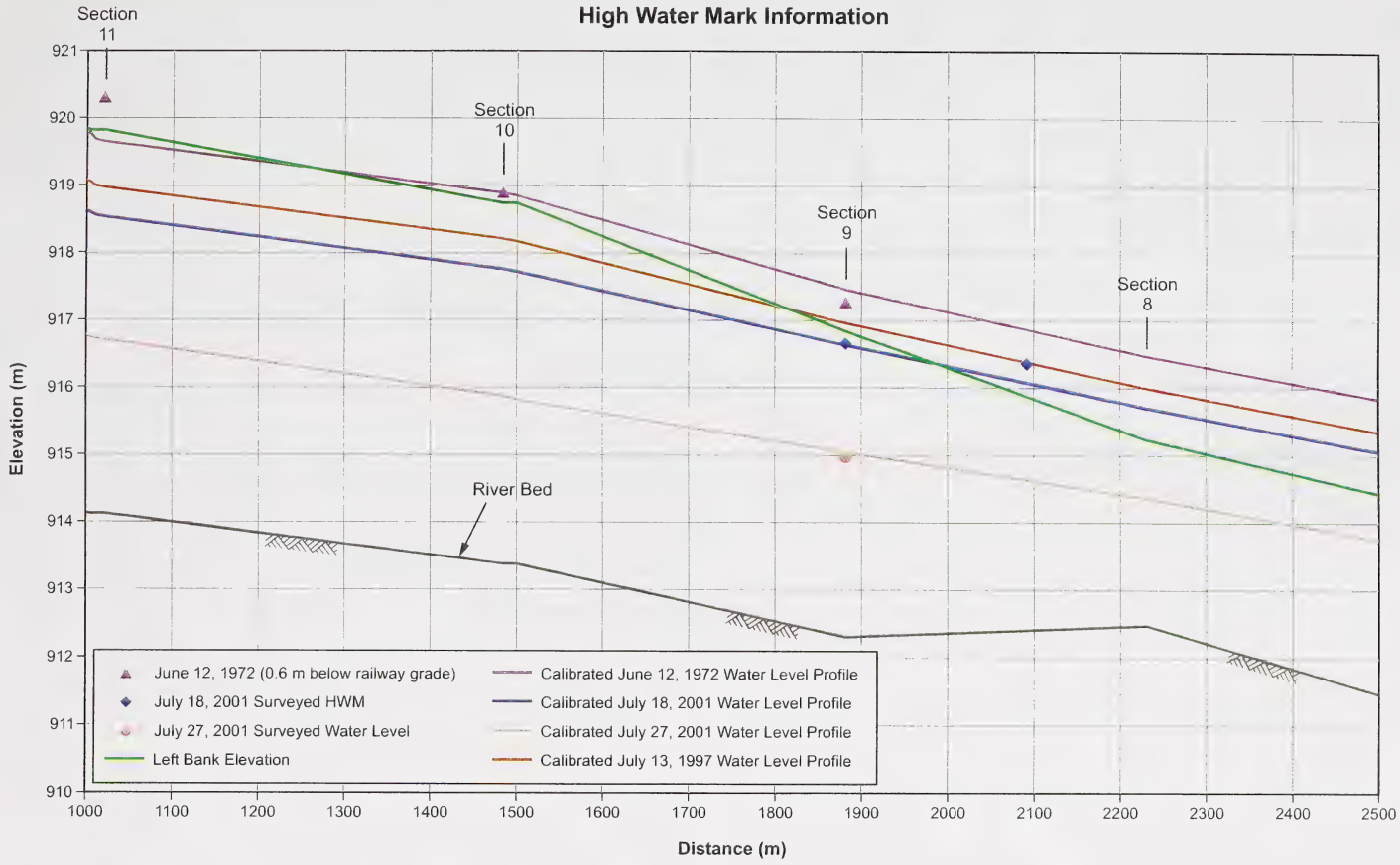
DATE	04/03/08

SMOKY RIVER COAL FLOOD RISK MAPPING STUDY

STUDY REACH AND CROSS SECTION LOCATIONS

FILE (CDR) 857-04-03-08-A1 | JOB NO. 857 | FIGURE 2

High Water Mark Information



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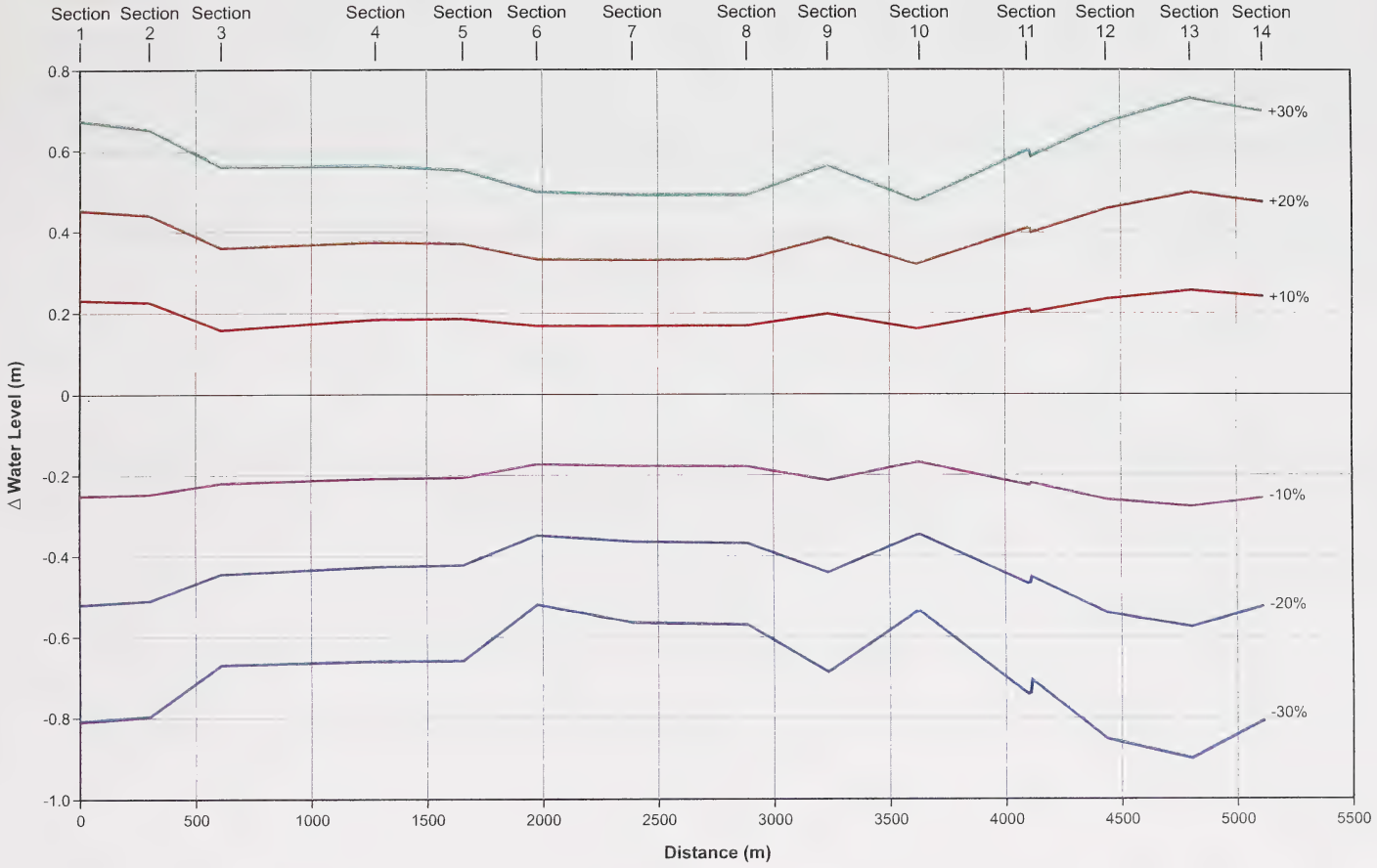
SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

CALIBRATION RESULTS AT SRC PLANT SITE

FILE (CDR) 857-04-03-08-A1 | JOB NO. 857 | FIGURE 3



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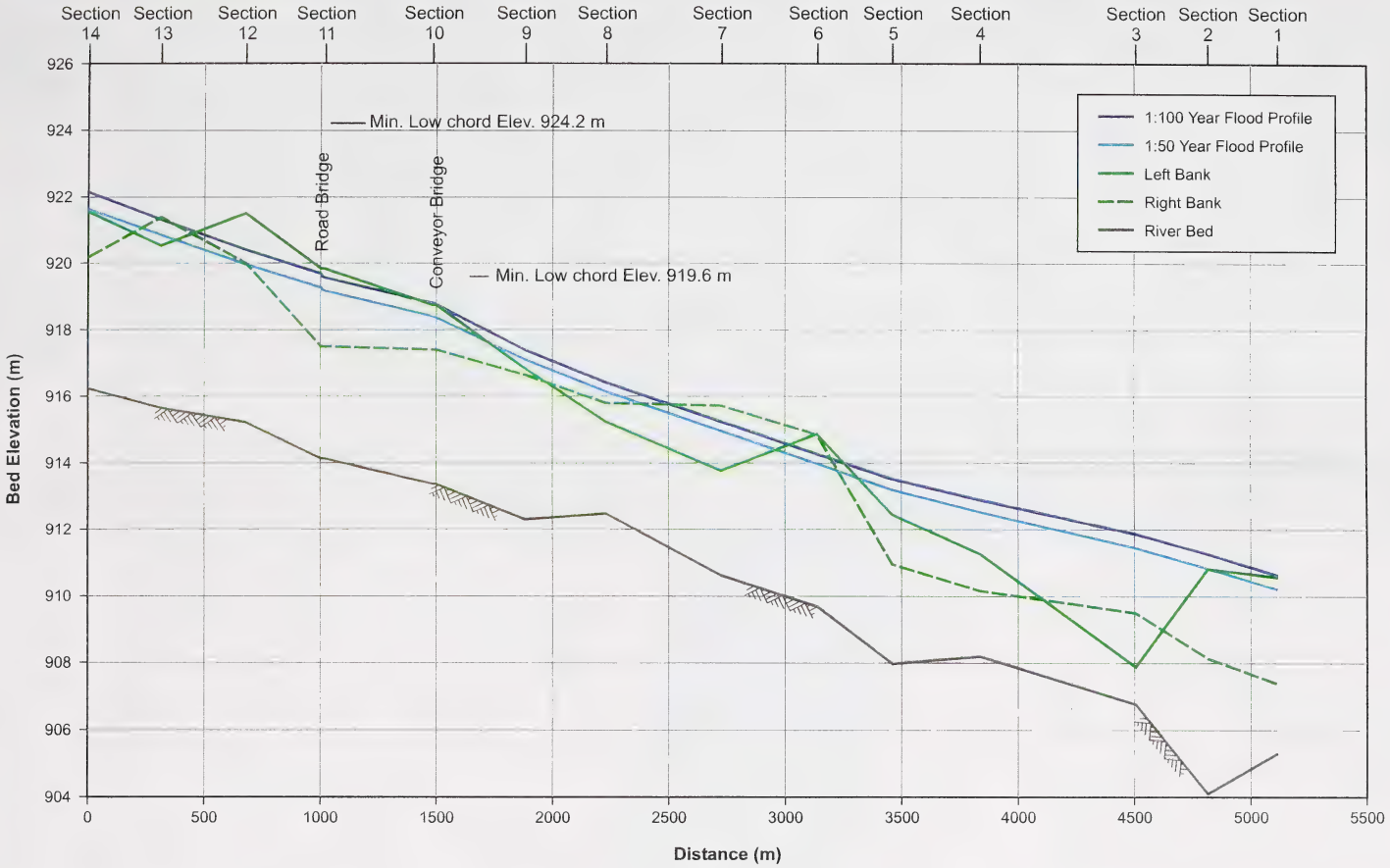
DATE	04/03/08

SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

MANNING'S ROUGHNESS SENSITIVITY COMPARISON

FILE (CDR) 857-04-03-08-A1 | JOB NO. 857 | FIGURE 4



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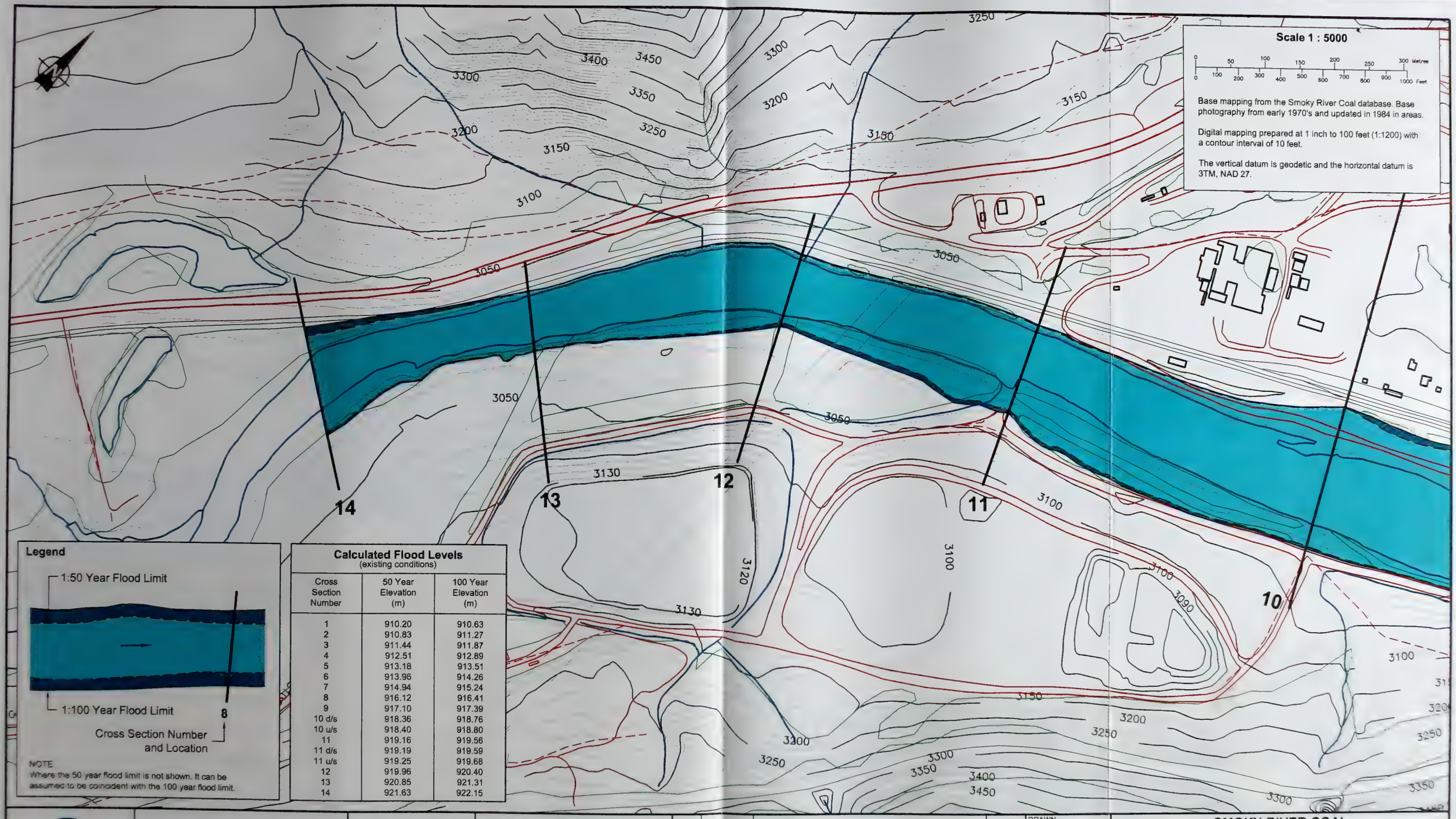
SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

50 AND 100 YEAR
WATER SURFACE PROFILES

FILE (CDR) 857-04-03-08-A1 | JOB NO. 857 | FIGURE 5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0 50 100 150 200 250 300 Metres
0 100 200 300 400 500 600 700 800 900 1000 Feet
Base mapping from the Smoky River Coal database. Base photography from early 1970's and updated in 1984 in areas.
Digital mapping prepared at 1 inch to 100 feet (1:1200) with a contour interval of 10 feet.
The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.
14
13
12
11
10
3250
3300
3400
3450
3350
3200
3150
3100
3050
3130
3120
3090
Legend
1:50 Year Flood Limit
1:100 Year Flood Limit
8
Cross Section Number and Location
NOTE
Where the 50 year flood limit is not shown. It can be assumed to be coincident with the 100 year flood limit.

Calculated Flood Levels
(existing conditions)

Cross Section Number	50 Year Elevation (m)	100 Year Elevation (m)
1	910.20	910.63
2	910.83	911.27
3	911.44	911.87
4	912.51	912.89
5	913.18	913.51
6	913.96	914.26
7	914.94	915.24
8	916.12	916.41
9	917.10	917.39
10 d/s	918.36	918.76
10 u/s	918.40	918.80
11	919.16	919.56
11 d/s	919.19	919.59
11 u/s	919.25	919.68
12	919.96	920.40
13	920.85	921.31
14	921.63	922.15

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FLOOD RISK MAPPING STUDY

SMOKY RIVER FLOOD FREQUENCY MAP 1/3

FILE (DWG) 857-04-03-05-A1
JOB NO 857
FIGURE 6.1

Legend

1:50 Year Flood Limit

1:100 Year Flood Limit

8 — Cross Section Number and Location

NOTE:
Where the 50 year flood limit is not shown. It can be assumed to be coincident with the 100 year flood limit.

Calculated Flood Levels
(existing conditions)

Cross Section Number	50 Year Elevation (m)	100 Year Elevation (m)
1	910.20	910.63
2	910.83	911.27
3	911.44	911.87
4	912.51	912.89
5	913.18	913.51
6	913.96	914.26
7	914.94	915.24
8	916.12	916.41
9	917.10	917.39
10 d/s	918.36	918.76
10 u/s	918.40	918.80
11	919.16	919.56
11 d/s	919.19	919.59
11 u/s	919.25	919.68
12	919.96	920.40
13	920.85	921.31
14	921.63	922.15

Scale 1 : 5000

0 50 100 150 200 250 300 Metres
0 100 200 300 400 500 600 700 800 900 1000 Feet

Base mapping from the Smoky River Coal database. Base photography from early 1970's and updated in 1984 in areas.

Digital mapping prepared at 1 inch to 100 feet (1:1200) with a contour interval of 10 feet.

The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.

Cell 1
Cell 2
Cell 3
Cell 4
Cell 5
Wetland

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FLOOD RISK MAPPING STUDY

SMOKY RIVER FLOOD FREQUENCY MAP 2/3

FILE (DWG) 857-04-03-05-A1
JOB NO 857
FIGURE 6.2

Scale 1 : 5000

0 50 100 150 200 250 300 Metres

0 100 200 300 400 500 600 700 800 900 1000 Feet

Base mapping from the Smoky River Coal database. Base photography from early 1970's and updated in 1984 in areas.

Digital mapping prepared at 1 inch to 100 feet (1:1200) with a contour interval of 10 feet.

The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.

3200
3150
3100
3050
3000
3000
3050
3100
3150
3200
3250
3300
3350

1 2 3 4 5

Legend

1:50 Year Flood Limit

1:100 Year Flood Limit

8 Cross Section Number and Location

NOTE:
Where the 50 year flood limit is not shown. It can be assumed to be coincident with the 100 year flood limit.

Calculated Flood Levels
(existing conditions)

Cross Section Number	50 Year Elevation (m)	100 Year Elevation (m)
1	910.20	910.63
2	910.83	911.27
3	911.44	911.87
4	912.51	912.89
5	913.18	913.51
6	913.96	914.26
7	914.94	915.24
8	916.12	916.41
9	917.10	917.39
10 d/s	918.36	918.76
10 u/s	918.40	918.80
11	919.16	919.56
11 d/s	919.19	919.59
11 u/s	919.25	919.68
12	919.96	920.40
13	920.85	921.31
14	921.63	922.15

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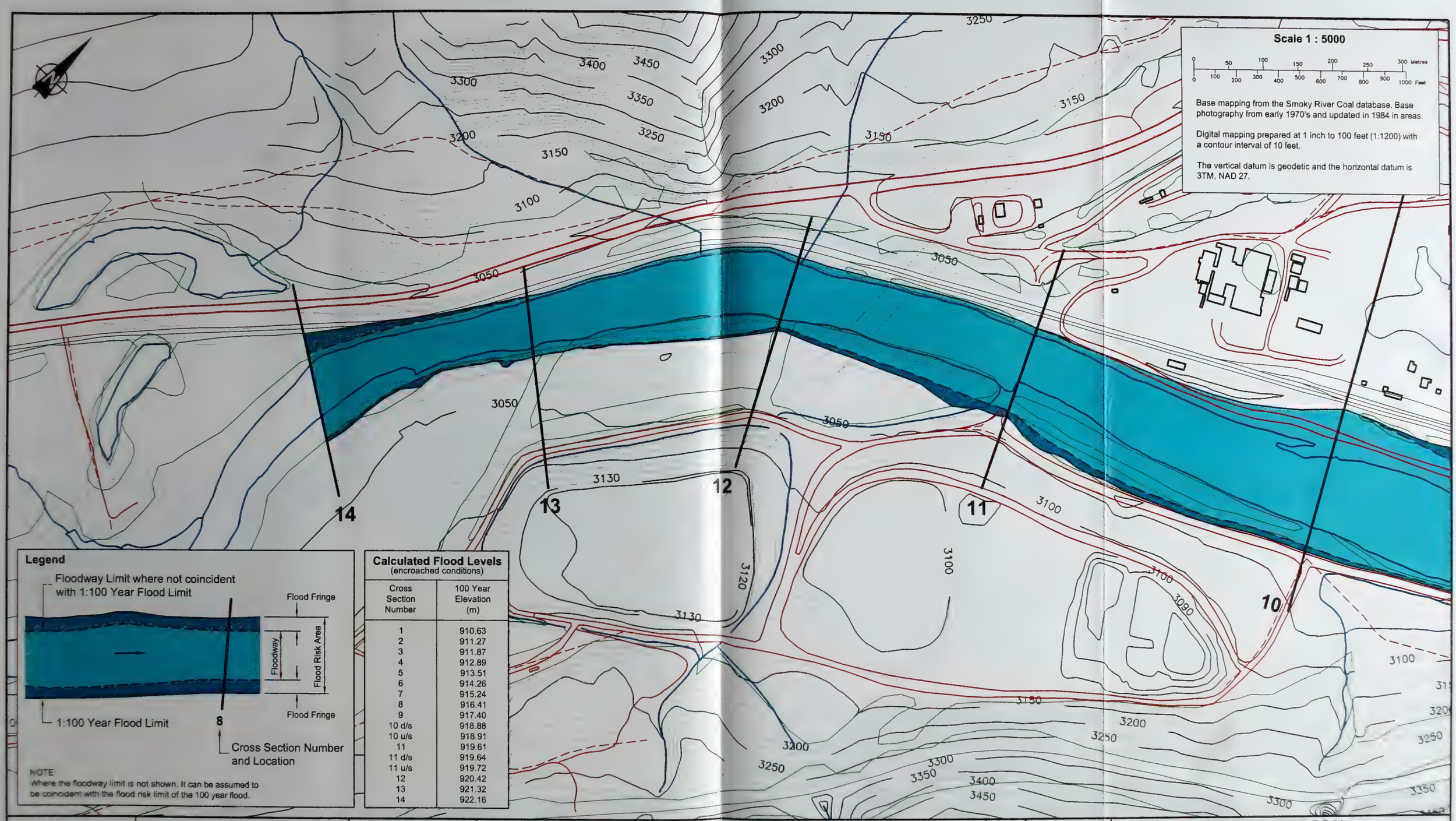
SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

SMOKY RIVER FLOOD FREQUENCY MAP 3/3

FILE (DWG) 857-04-03-05-A1 JOB NO. 857 FIGURE 6.3


Scale 1 : 5000
0 50 100 150 200 250 300 Metres
0 100 200 300 400 500 600 700 800 900 1000 Feet
Base mapping from the Smoky River Coal database. Base photography from early 1970's and updated in 1984 in areas.
Digital mapping prepared at 1 inch to 100 feet (1:1200) with a contour interval of 10 feet.
The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.
14
13
12
11
10
3400
3450
3300
3350
3250
3200
3150
3100
3050
3130
3120
3090
Legend
Floodway Limit where not coincident with 1:100 Year Flood Limit
Flood Fringe
Floodway
Flood Risk Area
Flood Fringe
1:100 Year Flood Limit
8
Cross Section Number and Location
NOTE
Where the floodway limit is not shown. It can be assumed to be coincident with the flood risk limit of the 100 year flood.

Calculated Flood Levels
(encroached conditions)

Cross Section Number	100 Year Elevation (m)
1	910.63
2	911.27
3	911.87
4	912.89
5	913.51
6	914.26
7	915.24
8	916.41
9	917.40
10 d/s	918.88
10 u/s	918.91
11	919.61
11 d/s	919.64
11 u/s	919.72
12	920.42
13	921.32
14	922.16

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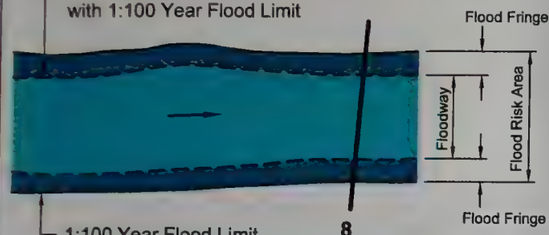
FLOOD RISK MAPPING STUDY

SMOKY RIVER
FLOOD RISK MAP 1/3

FILE (DWG) 857-04-03-08-A1
JOB NO. 857
FIGURE 7.1

Legend

Floodway Limit where not coincident with 1:100 Year Flood Limit



1:100 Year Flood Limit

8 — Cross Section Number and Location

NOTE:
Where the floodway limit is not shown. It can be assumed to be coincident with the flood risk limit of the 100 year flood.

Calculated Flood Levels
(encroached conditions)

Cross Section Number	100 Year Elevation (m)
1	910.63
2	911.27
3	911.87
4	912.89
5	913.51
6	914.26
7	915.24
8	916.41
9	917.40
10 d/s	918.88
10 u/s	918.91
11	919.61
11 d/s	919.64
11 u/s	919.72
12	920.42
13	921.32
14	922.16

Scale 1 : 5000

0 50 100 150 200 250 300 Metres
0 100 200 300 400 500 600 700 800 900 1000 Feet

Base mapping from the Smoky River Coal database. Base photography from early 1970's and updated in 1984 in areas.

Digital mapping prepared at 1 inch to 100 feet (1:1200) with a contour interval of 10 feet.

The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.

Cell 1 Cell 2 Cell 3 Cell 4 Cell 5 Wetland

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APP Dave Cooper
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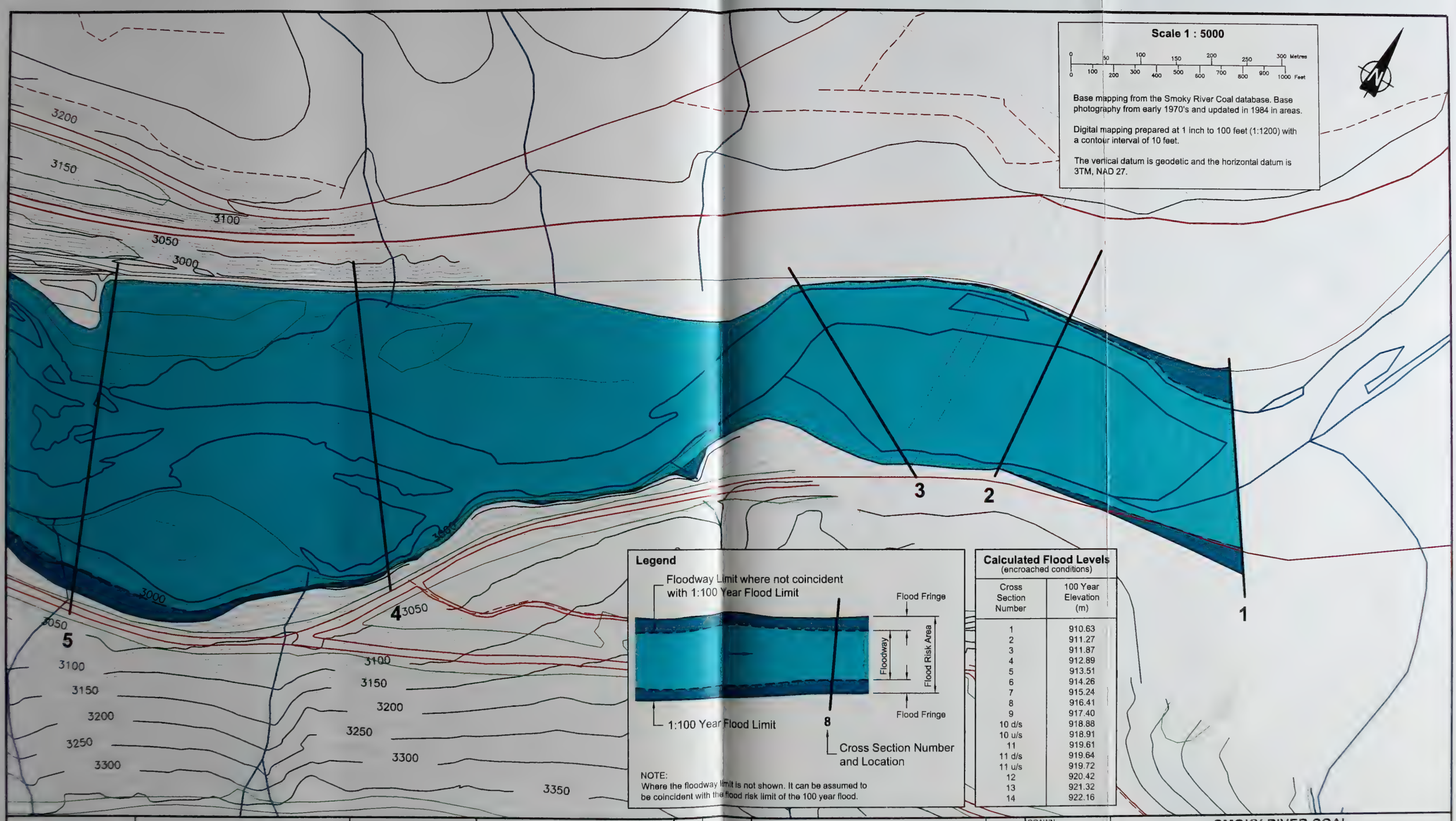
JOB NO 857

SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

SMOKY RIVER
FLOOD RISK MAP 2/3

FIGURE 7.2


Scale 1 : 5000
0 50 100 150 200 250 300 Metres
0 100 200 300 400 500 600 700 800 900 1000 Feet
Base mapping from the Smoky River Coal database. Base photography from early 1970's and updated in 1984 in areas.
Digital mapping prepared at 1 inch to 100 feet (1:1200) with a contour interval of 10 feet.
The vertical datum is geodetic and the horizontal datum is 3TM, NAD 27.
3200
3150
3100
3050
3000
3300
3350
1
2
3
4
5
Legend
Floodway Limit where not coincident with 1:100 Year Flood Limit
Flood Fringe
Floodway
Flood Risk Area
Flood Fringe
1:100 Year Flood Limit
8
Cross Section Number and Location
NOTE:
Where the floodway limit is not shown. It can be assumed to be coincident with the flood risk limit of the 100 year flood.

Calculated Flood Levels
(encroached conditions)

Cross Section Number	100 Year Elevation (m)
1	910.63
2	911.27
3	911.87
4	912.89
5	913.51
6	914.26
7	915.24
8	916.41
9	917.40
10 d/s	918.88
10 u/s	918.91
11	919.61
11 d/s	919.64
11 u/s	919.72
12	920.42
13	921.32
14	922.16

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DESIGN Andy Wong
APP Dave Cooper
SCALE 1 : 5000
DATE 04/03/05
FILE (DWG) 857-04-03-08-A1
JOB NO 857

SMOKY RIVER COAL
FLOOD RISK MAPPING STUDY

SMOKY RIVER
FLOOD RISK MAP 3/3

FIGURE 7.3

HEC-RAS Version 3.0.1 May 2002
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Smoky River Mine Flood Risk Study
Project File : SRM.prj
Run Date and Time: 05/03/04 2:38:00 PM

Project in SI units

Project Description:
Smoky River Coal Flood Risk Study

FLOW DATA

Flow Title: Q for Calibration s = 0.002
Flow File : C:\Jobs\857 AENV SRC\HEC-RAS Input\SRM.f03

Flow Data (m3/s)

River	Reach	RS	May 23 2001	06-Aug-99	27-Jul-01	1:2 yr	1:10 yr	2001 Max Inst	1997 Peak	1:50 yr
Smoky River	d/s Grand Cache	14	83.3	198	217	442	707	810	1012	1100

River	Reach	RS	1972 Max Daily	1:100 yr	1972 Max Inst
Smoky River	d/s Grand Cache	14	1230	1320	1380

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Smoky River	d/s Grand Cache	May 23 2001		Normal S = .002
Smoky River	d/s Grand Cache	06-Aug-99		Normal S = .002
Smoky River	d/s Grand Cache	27-Jul-01		Normal S = .002
Smoky River	d/s Grand Cache	1:2 yr		Normal S = .002
Smoky River	d/s Grand Cache	1:10 yr		Normal S = .002
Smoky River	d/s Grand Cache	2001 Max Inst		Normal S = .002
Smoky River	d/s Grand Cache	1997 Peak		Normal S = .002

GEOMETRY DATA

Geometry Title: Section 1 - 14 (n = 0.044)
Geometry File : C:\Jobs\857 AENV SRC\HEC-RAS Input\SRM.g09

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 14

INPUT
Description: Section 14
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	924.07	5.437	922.06	15.577	923.97	27.461	924.11	28.345	923.87
39.507	921.36	50.754	921.51	52.791	922.05	55.634	922.27	57.252	922.34
62.916	922.23	67.066	922.39	68.658	922.39	69.485	922.16	73.828	921.77
84.436	921.6	94.047	921.75	101.955	921.55	108.546	917.94	111.41	916.73
113.91	916.24	149.205	916.48	153.133	916.7	160.467	917.07	165.519	917.27
166.851	917.68	169.776	917.26	175.837	916.96	180.686	917.17	181.636	917.37
189.585	917.82	203.387	917.57	208.437	918.93	210.177	920.18	219.749	921.31
224.137	922.16	237.634	922.37	258.885	923.98	284.471	926.04	301.154	928.46

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	28.345	.08	101.955	.044	210.177	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
101.955	210.177	316	313	309	.1	.3

Left Levee Station= 68.658 Elevation= 922.394

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 13

INPUT
Description: Section 13
Station Elevation Data num= 36

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	930.56	7.997	928.9	23.553	920.31	25.823	920.36	27.617	921.11
29.923	921.17	35.19	921	39.773	921.04	41.182	920.95	42.621	920.53
46.748	917.6	48.37	916.63	56.007	915.65	65.226	915.69	75.254	915.69
85.355	915.68	94.779	915.77	101.194	915.99	111.116	916.6	113.552	917.03
120.956	917.7	125.625	921.39	145.905	923.48	163.749	925.59	186.099	928.31
218.983	931.39	233.12	932.63	248.623	933.8	254.905	937.13	259.223	937.06
263.52	937.63	267.948	936.97	268.807	936.74	269.57	937.07	276.243	937.44
309.329	953.23								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	42.621	.044	125.625	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
42.621	125.625	387	365	347	.1	.3

Left Levee Station= 29.923 Elevation= 921.204

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 12

INPUT
Description: Section 12
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	936.64	29.685	920.26	32.276	920.14	34.987	921.15	36.522	921.17
38.228	921.1	38.839	920.96	43.13	920.87	49.055	920.92	50.863	920.92
51.984	920.57	52.555	920.67	55.397	920.59	58.527	921.51	62.68	917.87
64.154	916.9	67.918	915.94	79.854	915.28	88.429	915.87	99.34	915.65
108.305	915.36	118.862	915.22	134.112	915.52	136.532	915.53	140.745	916.09
151.16	917.02	152.816	918.43	159.117	920	172.818	921	193.246	922.01
213.271	924.08	233.961	924.32	253.595	925.42	267.634	926.44	278.062	926.2
283.058	930.04	288.004	930.01	293.002	929.81	295.901	927.79	303.558	927.95
308.381	930.52	312.349	930.83	362.209	951.36				

```
Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  58.527    .044 159.117      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       58.527 159.117            329.5   325.5   325.5             .1       .3
Left Levee       Station=  58.527       Elevation= 921.514

CROSS SECTION           RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11.3

INPUT
Description: u/s end of road bridge (repeat of Section 11 + abutments)
Station Elevation Data     num=      41
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   932.29    7.812   932.46   13.403   932.58   16.147   932.79   56.816  932.932
  73.062   922.66   77.402   920.86   79.915   920.65   81.133   920.92   89.104   920.98
  90.672   920.99   91.284   920.85   95.429   920.82  100.174   920.91   101.45   920.85
 102.453    920.5   108.14   920.22   109.49   919.63  114.025   919.51  116.522   919.83
 120.919    917.2  122.619   916.42  128.763   915.51  136.324   914.71  145.171   914.58
 155.303   914.39  162.977   914.63  172.078    914.7  183.857   914.13  190.778   914.56
 195.711   915.49  218.267   916.04  219.975   916.41  222.803    917.5  234.456   918.42
 242.599   919.13   250.44  925.678  270.918   924.53  278.946   924.58  287.487   924.54
 357.405      946

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 120.919    .044 234.456      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       116.522 222.803              6.5     6.5     6.5             .1       .3

BRIDGE                  RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11.2

INPUT
Description: Road Bridge
Distance from Upstream XS =      .09
Deckway Width             =     6.3
Weir Coefficient          =    1.44
Upstream  Deck/Roadway Coordinates
    num=       18
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  56.816  932.93  932.93  60.245   932.8  931.28  71.675  932.37  930.84
  78.533  932.11  930.58  86.153  931.82  930.29  90.725  931.64  930.12
 108.404  930.97  929.45 118.767  930.58  929.06 121.815  930.46  928.94
 146.808  929.51  927.99 171.802  928.56  927.04 196.796  927.62  926.09
 221.789  926.67  925.14 227.504  926.45  924.92 232.457  926.26  924.74
 233.981   926.2  924.68 246.783  925.72  924.19  250.44  925.68  925.68

Upstream Bridge Cross Section Data
Station Elevation Data     num=      41
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   932.29    7.812   932.46   13.403   932.58   16.147   932.79   56.816  932.932
  73.062   922.66   77.402   920.86   79.915   920.65   81.133   920.92   89.104   920.98
  90.672   920.99   91.284   920.85   95.429   920.82  100.174   920.91   101.45   920.85
 102.453    920.5   108.14   920.22   109.49   919.63  114.025   919.51  116.522   919.83
 120.919    917.2  122.619   916.42  128.763   915.51  136.324   914.71  145.171   914.58
 155.303   914.39  162.977   914.63  172.078    914.7  183.857   914.13  190.778   914.56
 195.711   915.49  218.267   916.04  219.975   916.41  222.803    917.5  234.456   918.42
 242.599   919.13   250.44  925.678  270.918   924.53  278.946   924.58  287.487   924.54
 357.405      946

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 120.919    .044 234.456      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       116.522 222.803             .1       .3

Downstream  Deck/Roadway Coordinates
```

```
   num=      18
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  56.816  932.93  932.93  60.245   932.8  931.28  71.675  932.37  930.84
  78.533  932.11  930.58  86.153  931.82  930.29  90.725  931.64  930.12
 108.404  930.97  929.45 118.767  930.58  929.06 121.815  930.46  928.94
 146.808  929.51  927.99 171.802  928.56  927.04 196.796  927.62  926.09
 221.789  926.67  925.14 227.504  926.45  924.92 232.457  926.26  924.74
 233.981   926.2  924.68 246.783  925.72  924.19  250.44  925.68  925.68

Downstream Bridge Cross Section Data
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29   7.812  932.46  13.403  932.58  16.147  932.79  56.816 932.932
  73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92  89.104  920.98
  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91  101.45  920.85
 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51 116.522  919.83
 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71 145.171  914.58
 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13 190.778  914.56
 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5 234.456  918.42
 242.599  919.13  250.44 925.678 270.918  924.53 278.946  924.58 287.487  924.54
 357.405     946

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 116.522    .044 222.803      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       116.522 222.803             .1       .3

Upstream Embankment side slope                =       0 horiz. to 1.0 vertical
Downstream Embankment side slope              =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins           =
Energy head used in spillway design           =
Spillway height used in design                =
Weir crest shape                              = Broad Crested

Number of Piers =  6

Pier Data
Pier Station     Upstream=  78.534    Downstream=  78.534
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  922.71     1.5  923.85      .9  923.85      .9  930.58
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  922.71     1.5  923.85      .9  923.85      .9  930.58

Pier Data
Pier Station     Upstream= 121.815    Downstream= 121.815
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  916.61     1.5   920.8      .9   920.8      .9  928.94
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  916.61     1.5   920.8      .9   920.8      .9  928.94

Pier Data
Pier Station     Upstream= 146.809    Downstream= 146.809
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  915.09     1.5  919.89      .9  919.89      .9  927.99
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  915.09     1.5  919.89      .9  919.89      .9  927.99

Pier Data
Pier Station     Upstream= 171.802    Downstream= 171.802
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  913.94     1.5  919.89      .9  919.89      .9  927.04
```

```
Downstream      num=        4
    Width   Elev     Width   Elev     Width   Elev     Width   Elev
     1.5  913.94      1.5  919.89       .9  919.89       .9  927.04

Pier Data
Pier Station     Upstream= 196.796    Downstream= 196.796
Upstream      num=        4
    Width   Elev     Width   Elev     Width   Elev     Width   Elev
     1.5  915.09      1.5  919.89       .9  919.89       .9  926.09
Downstream      num=        4
    Width   Elev     Width   Elev     Width   Elev     Width   Elev
     1.5  915.09      1.5  919.89       .9  919.89       .9  926.09

Pier Data
Pier Station     Upstream=  221.79    Downstream=  221.79
Upstream      num=        4
    Width   Elev     Width   Elev     Width   Elev     Width   Elev
     1.5  916.76      1.5  919.89       .9  919.89       .9  925.14
Downstream      num=        4
    Width   Elev     Width   Elev     Width   Elev     Width   Elev
     1.5  916.76      1.5  919.89       .9  919.89       .9  925.14

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11.1

INPUT
Description: d/s end of road bridge (repeat of Section 11 + abutments)
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29    7.812  932.46  13.403  932.58  16.147  932.79  56.816 932.932
  73.062  922.66   77.402  920.86  79.915  920.65  81.133  920.92  89.104  920.98
  90.672  920.99   91.284  920.85  95.429  920.82 100.174  920.91  101.45  920.85
 102.453   920.5   108.14  920.22  109.49  919.63 114.025  919.51 116.522  919.83
 120.919   917.2  122.619  916.42 128.763  915.51 136.324  914.71 145.171  914.58
 155.303  914.39  162.977  914.63 172.078   914.7 183.857  914.13 190.778  914.56
 195.711  915.49  218.267  916.04 219.975  916.41 222.803   917.5 234.456  918.42
 242.599  919.13   250.44 925.678 270.918  924.53 278.946  924.58 287.487  924.54
 357.405     946

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 116.522     .044 222.803      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       116.522 222.803               10      10      10             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11

INPUT
Description: Section 11 (10 m d/s of road bridge)
Station Elevation Data    num=      42
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29    7.812  932.46  13.403  932.58  16.147  932.79  20.286  931.71
  42.044  928.85   73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92
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  89.104  920.98  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91
  101.45  920.85 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51
 116.522  919.83 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71
 145.171  914.58 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13
 190.778  914.56 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5
 234.456  918.42 242.599  919.13 262.642  921.21 270.918  924.53 278.946  924.58
 287.487  924.54 357.405     946

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 116.522    .044 222.803      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       116.522 222.803               454     464     463             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 10

INPUT
Description: Section 10 (10 m u/s of conveyor bridge)
Station Elevation Data    num=      58
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   934.25   17.643    929.5   37.169    923.9   54.341   923.37   58.616   920.46
  61.383   920.39   64.153   921.52   67.986   921.33    73.49   921.26   78.422   919.48
  98.512    919.6  118.193   919.25  138.275   919.04  156.498   919.04  176.621   919.02
 194.961   919.24  213.648    919.2   232.11   919.31  250.513   919.22  268.085   919.33
 286.051    919.3   304.81   919.09  324.443   919.46  328.775    919.2  342.616    919.6
 354.711   919.55  359.317    919.4  362.534   919.27  365.306   919.28   369.93   916.26
 392.857   917.44  394.332   917.63  399.971    918.3  402.402   917.87  406.382   918.04
 409.873   917.98  420.114   918.74  425.336   916.21  431.704   915.88  438.429   914.74
 447.285   914.35  457.649   914.55  468.944   914.82  473.979   914.93  492.316   915.21
 505.306   915.04  517.941   914.09  527.968   913.38  554.325    914.1  554.732   914.94
 555.897    917.4  569.758   918.34  579.359   920.93  583.624   921.14  590.788   921.15
  610.25   921.93  634.989   923.99   660.47   927.24

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 365.306    .075 420.114    .044 555.897    .075 579.359      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       420.114 555.897                16      16      16             .1       .3
Left Levee      Station= 342.616      Elevation= 919.604

BRIDGE                 RIVER: Smoky River
REACH: d/s Grand Cache    RS: 9.9

INPUT
Description: Conveyor Bridge
Distance from Upstream XS =      10
Deck/Roadway Width        =       6
Weir Coefficient          =    1.44
Upstream  Deck/Roadway Coordinates
    num=       4
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  414.13  919.73  919.63  508.13   920.3   920.2  554.73  920.74  920.64
  579.36  921.04  920.94

Upstream Bridge Cross Section Data
Station Elevation Data    num=      58
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   934.25   17.643    929.5   37.169    923.9   54.341   923.37   58.616   920.46
  61.383   920.39   64.153   921.52   67.986   921.33    73.49   921.26   78.422   919.48
  98.512    919.6  118.193   919.25  138.275   919.04  156.498   919.04  176.621   919.02
 194.961   919.24  213.648    919.2   232.11   919.31  250.513   919.22  268.085   919.33
 286.051    919.3   304.81   919.09  324.443   919.46  328.775    919.2  342.616    919.6
 354.711   919.55  359.317    919.4  362.534   919.27  365.306   919.28   369.93   916.26
 392.857   917.44  394.332   917.63  399.971    918.3  402.402   917.87  406.382   918.04
 409.873   917.98  420.114   918.74  425.336   916.21  431.704   915.88  438.429   914.74
 447.285   914.35  457.649   914.55  468.944   914.82  473.979   914.93  492.316   915.21
 505.306   915.04  517.941   914.09  527.968   913.38  554.325    914.1  554.732   914.94
 555.897    917.4  569.758   918.34  579.359   920.93  583.624   921.14  590.788   921.15
```

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  610.25  921.93 634.989  923.99  660.47  927.24

Manning's n Values          num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 365.306    .075 420.114    .044 555.897    .075 579.359      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       420.114 555.897             .1       .3
Left Levee      Station= 342.616      Elevation= 919.604

Downstream  Deck/Roadway Coordinates
    num=       4
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  414.13  919.73  919.63  508.13   920.3   920.2  554.73  920.74  920.64
  579.36  921.04  920.94

Downstream Bridge Cross Section Data
Station Elevation Data     num=      58
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0   934.25   17.643    929.5   37.169    923.9   54.341   923.37   58.616   920.46
  61.383   920.39   64.153   921.52   67.986   921.33    73.49   921.26   78.422   919.48
  98.512    919.6  118.193   919.25  138.275   919.04  156.498   919.04  176.621   919.02
 194.961   919.24  213.648    919.2   232.11   919.31  250.513   919.22  268.085   919.33
 286.051    919.3   304.81   919.09  324.443   919.46  328.775    919.2  342.616    919.6
 354.711   919.55  359.317    919.4  362.534   919.27  365.306   919.28   369.93   916.26
 392.857   917.44  394.332   917.63  399.971    918.3  402.402   917.87  406.382   918.04
 409.873   917.98  420.114   918.74  425.336   916.21  431.704   915.88  438.429   914.74
 447.285   914.35  457.649   914.55  468.944   914.82  473.979   914.93  492.316   915.21
 505.306   915.04  517.941   914.09  527.968   913.38  554.325    914.1  554.732   914.94
 555.897    917.4  569.758   918.34  579.359   920.93  583.624   921.14  590.788   921.15
  610.25   921.93  634.989   923.99   660.47   927.24

Manning's n Values          num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 365.306    .075 420.114    .044 555.897    .075 579.359      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       420.114 555.897             .1       .3

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Piers =  3

Pier Data
Pier Station     Upstream= 415.982    Downstream= 415.982
Upstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      3.7   918.4      3.7   919.1      .9   919.1      .9  919.63
Downstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      3.7   918.4      3.7   919.1      .9   919.1      .9  919.63

Pier Data
Pier Station     Upstream= 508.132    Downstream= 508.132
Upstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
        4  914.6        4   915.4      .9   915.4      .9   920.2
Downstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
        4  914.6        4   915.4      .9   915.4      .9   920.2

Pier Data
Pier Station     Upstream= 554.732    Downstream= 554.732
Upstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
```

```
      3   914.2       3     915       .6     915       .6  920.64
Downstream      num=        4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      3   914.2       3     915       .6     915       .6  920.64

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
      Energy
Selected Low Flow Methods = Energy

High Flow Method
      Energy

Additional Bridge Parameters
      Add Friction component to Momentum
      Do not add Weight component to Momentum
      Class B flow critical depth computations use critical depth
          inside the bridge at the upstream end
      Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 9.8

INPUT
Description: d/s end of conveyor bridge (repeat of Section 10)
Station Elevation Data    num=      58
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  934.25  17.643   929.5  37.169   923.9  54.341  923.37  58.616  920.46
  61.383  920.39  64.153  921.52  67.986  921.33   73.49  921.26  78.422  919.48
  98.512   919.6 118.193  919.25 138.275  919.04 156.498  919.04 176.621  919.02
 194.961  919.24 213.648   919.2  232.11  919.31 250.513  919.22 268.085  919.33
 286.051   919.3  304.81  919.09 324.443  919.46 328.775   919.2 342.616   919.6
 354.711  919.55 359.317   919.4 362.534  919.27 365.306  919.28  369.93  916.26
 392.857  917.44 394.332  917.63 399.971   918.3 402.402  917.87 406.382  918.04
 409.873  917.98 420.114  918.74 425.336  916.21 431.704  915.88 438.429  914.74
 447.285  914.35 457.649  914.55 468.944  914.82 473.979  914.93 492.316  915.21
 505.306  915.04 517.941  914.09 527.968  913.38 554.325   914.1 554.732  914.94
 555.897   917.4 569.758  918.34 579.359  920.93 583.624  921.14 590.788  921.15
  610.25  921.93 634.989  923.99  660.47  927.24

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 365.306    .075 420.114    .044 555.897    .075 579.359      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       420.114 555.897              386     382     395             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 9

INPUT
Description: Section 9
Station Elevation Data    num=      52
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  928.12    6.55  925.71   34.08  924.65   57.33  923.76   66.92  920.69
   69.61  918.24   71.38   918.2   75.22  919.46   95.52   919.4  118.05   918.2
   142.2  918.61  171.79  918.64  192.63  918.66  209.99  918.69  212.58  918.74
  214.39  918.73   238.1  918.28   263.5  918.04  281.92  917.87  282.79   917.6
  285.95  917.52  286.62  918.05  292.44  917.97   321.8  917.88  323.11  917.85
  324.62  917.39  326.54  917.36   328.5  917.36  333.24  916.94  354.09  916.74
  372.59  917.15  388.91  917.02  410.84  916.71  425.76  916.55  440.01  916.84
  443.81  914.56   445.8  913.61  457.26  912.31  470.24  912.45  473.76  912.65
  482.21   913.1  490.31  913.27   498.8  913.54  505.41  913.63  507.43  913.74
  513.98  913.78  519.44  913.53  523.69  913.75  523.71  913.76  526.18  914.41
     528  916.64   537.5  928.28

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 323.11    .075  440.01    .044     528      .1
```

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Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       440.01     528               361     349     338             .1       .3
Left Levee      Station=  286.62      Elevation= 918.054

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 8

INPUT
Description: Section 8
Station Elevation Data    num=      54
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  930.77  10.556  926.07  37.983  922.16  40.828  920.79  42.857  920.72
  44.943  920.88  50.093  920.62  53.658  920.49  70.123  919.11  89.495  918.12
 109.118  917.62 138.077  917.11 139.983     917  143.06  917.07  145.28  915.87
 152.632  915.96 153.224  916.22 161.431  916.47 174.454  916.72 179.537  916.94
 183.894  917.09 189.089  917.02 190.487  916.98 191.076  916.73  192.36  916.67
 194.414   916.6 198.267  915.06 211.421  914.24 219.103  914.32 269.974  914.85
 296.092  914.96 313.509  915.14 324.342  915.23 326.557   914.1 327.093  913.61
  331.87  913.73  335.83  913.62 339.426  913.19 350.249  912.91 363.705  912.84
 375.787   912.8  390.97  912.78 405.073  912.48 408.592  912.57 416.152  912.75
 423.697  912.93 429.989  913.17 433.699  913.15 440.469  914.08 442.738  915.79
 451.766  917.26 484.386   939.5  484.96  939.18 496.485  938.96

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 198.267    .075 324.342    .044 442.738      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       324.342 442.738             425     495     512             .1       .3
Left Levee      Station= 183.894      Elevation= 917.024

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 7

INPUT
Description: Section 7
Station Elevation Data    num=      51
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  928.67    3.36   926.9  11.461  926.36  30.312  914.08 167.245   913.7
 171.025  915.41 175.594  915.78 188.462  916.25 193.584  916.28 202.726  916.37
 205.995  916.16 209.276  916.06 213.838  913.79  235.78     914 267.314   913.5
 289.239  913.15 290.112  912.58 290.264  911.94 308.701  911.95 309.993  912.57
 315.532  912.46 316.949  913.28 317.767   913.5 342.581  913.73 365.673  913.76
  367.65  912.59 368.964  911.77 372.768  911.43 374.939  911.46 376.227  911.95
  384.04  912.18 398.053  912.67 405.288  912.62 413.105   912.4 420.367   912.6
 423.985  913.25 427.939  913.17 439.358  913.07 443.907  912.88 455.008  912.52
 463.334  911.97 472.907  911.51 483.483  911.31 492.735  910.63 503.324  910.69
 511.799  912.09 513.307  913.65 514.658  915.71 535.524  917.68 551.617   921.8
 558.928  925.42

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 213.838    .075 365.673    .044 514.658      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       365.673 514.658             433     413     324             .1       .3
Left Levee      Station= 202.726      Elevation= 916.374

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 6

INPUT
Description: Section 6
Station Elevation Data    num=      60
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  941.03  36.586  926.46  72.903  919.01   80.09  915.57  84.486  913.62
  92.483  913.64  94.304  914.47   96.57  914.43  97.368  914.75  98.959  914.71
  108.57   914.7   110.2  915.05 111.499  915.03 113.816  914.98 114.953   915.3
 116.394  915.29 120.626  915.36 125.277  915.41 126.708  915.36 127.469  915.02
 128.582  914.95 130.733  914.86 136.233  912.65 138.806  912.01 139.192  911.56
 139.541  911.52  140.02  911.92 157.675  912.98 158.522  912.48  160.02  911.84
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  164.13  912.13 177.996  910.54 184.773  910.05 194.169  909.69 205.851  910.58
 215.432  911.32 226.784  911.88 235.056  912.14 245.785  912.42 265.115  912.61
 267.066  912.48 271.903  910.92 286.626  910.08 299.195  910.39 321.637  910.98
 333.577   912.1  356.16  912.16 372.686  912.19 377.284  911.89 378.705  912.78
 381.346  914.84 395.703  915.78 458.451  920.01 471.461  924.17 499.135  925.65
 518.804  928.84 522.494  930.69 525.976  930.51 526.676  930.23 538.283   930.4

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 130.733    .044 226.784    .075 267.066    .055 381.346      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       130.733 381.346              337     322     302             .1       .3
Left Levee      Station= 125.277      Elevation= 915.414

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 5

INPUT
Description: Section 5
Station Elevation Data    num=      43
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  911.76   7.142  914.49   8.714  914.53  14.614  914.74  17.734  914.72
   19.05  914.66   23.11  914.03  28.252  911.76   44.41   911.6  63.187  911.99
  80.798  911.83  97.838     912 137.199  912.12  147.26  913.58 152.936  914.07
  163.41  913.76  170.61  912.44 171.512  911.61 174.158  910.82 179.353  911.47
 183.533  910.22 194.654  907.98 205.312  908.98 216.583  909.36 223.573   909.5
 229.065  909.38 243.774  910.43 252.383  910.95 259.672  910.43 279.872  911.26
 297.665  911.45 314.848  910.98 331.802  911.13 348.708  911.27 361.484  910.46
 367.167  909.91 377.314  910.49 385.835  911.93 386.958   912.4 470.305  913.66
 483.268  919.74 483.867  919.77 495.554  919.78

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  170.61    .044 252.383    .075 348.708     .06 385.835      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       170.61 252.383              375     377     390             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 4

INPUT
Description: Section 4
Station Elevation Data    num=      57
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  933.24  27.836  913.11  29.506  913.78  30.992  913.79   35.69  913.87
  37.099  913.86   40.03  913.38  42.511  912.35  46.628  912.06  50.335  909.82
  55.232  908.78  58.028  909.43  61.829  910.46  80.847  910.84 112.349  910.78
 146.408  911.05  164.18  911.25 187.605  911.15   193.4  911.27 195.016  910.07
 195.769   909.9  198.79  908.93 199.823  908.58 205.904   908.2 216.233  908.38
 217.918  908.89  231.42  910.16 265.674  909.84 279.665  909.58 287.389  909.33
 292.692  909.18 295.426  909.75 300.728  909.51 307.679  908.95 313.992  908.67
   317.5  908.43 324.553  908.21 329.628  908.25 335.697  908.53 345.859  909.54
 350.111   910.1 351.174  910.66 366.364     911 378.301   910.9 393.549  910.89
  407.08  910.85 409.911  909.78 411.406  909.23 411.988  909.12 418.942  907.97
 423.852  909.12 424.379  909.19 428.639  911.23 429.529  911.66 453.046  924.07
 459.433  924.59 461.029  925.19

Manning's n Values        num=       8
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  46.628    .075  61.829     .08   193.4    .044  231.42      .07
 350.111     .08  407.08    .075 428.639      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         193.4  231.42              660     669     680             .1       .3
Left Levee      Station=   193.4      Elevation= 911.272
Right Levee     Station= 366.364      Elevation= 911.004

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 3
```

INPUT
Description: Section 3
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	919.23	12.736	911.66	16.46	911.48	19.199	912.43	21.081	912.41
22.925	912.3	29.593	911.6	33.225	909.22	38.481	907.47	58.524	907.34
60.605	907.94	78.25	908.49	91.632	908.31	93.901	908.05	96.097	908.26
104.381	908.27	120.463	907.89	123.098	907.68	131.152	906.99	136.429	906.97
142.858	906.84	149.822	906.78	155.72	906.83	169.75	907.65	173.137	908.95
173.435	909.5	174.959	909.62	186.752	909.98	201.521	909.35	202.594	909.66
202.662	909.69	210.077	909.73	226.206	908.65	245.149	908.93	272.887	909.5
284.417	909.16	285.448	908.66	293.589	908.52	298.293	907.67	310.215	907.85
312.023	908.42	312.217	909.06	342.659	925.51				

Manning's n Values num= 7

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	33.225	.075	60.605	.08	120.463	.044	173.435	.08
293.589	.075	312.217	.1						

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
120.463	173.435	329	310	277	.1	.3

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 2

INPUT
Description: Section 2
Station Elevation Data num= 39

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	934.05	47.29	909.13	68.234	909.29	95.832	909.44	101.615	911.1
104.512	911.29	105.952	911.21	108.422	910.82	113.385	907.57	115.625	906.67
122.137	904.1	126.563	904.55	132.316	905.72	146.729	906.31	155.534	906.66
164.697	907.45	166.661	908.14	168.369	908.08	179.94	908.79	188.878	908.91
193.258	907.57	195.764	907.48	201.438	909.12	216.344	909.26	233.226	909.37
254.394	908.95	270.249	908.86	274.696	908.19	283.844	908.63	302.766	908.27
303.211	907.66	303.925	907.3	312.112	907.23	318.042	907.01	325.075	907.1
329.563	906.77	331.748	907.48	332.208	908.3	349.848	921.12		

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	108.422	.044	166.661	.08	302.766	.07	332.208	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
108.422	166.661	258	300	300	.1	.3

Left Levee Station= 104.512 Elevation= 911.293

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 1

INPUT
Description: Section 1
Station Elevation Data num= 46

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	916.46	13.551	909.52	15.42	909.52	17.321	910.33	21.267	910.68
23.121	910.7	27.672	909.53	30.613	909.51	34.77	912.04	49.31	913.58
55.289	912.69	62.394	910.57	68.533	907.84	70.979	906.68	84.286	906.2
98.929	905.45	106.952	905.4	113.743	905.45	118.877	905.47	124.607	905.48
132.12	905.31	138.088	906.22	139.611	906.49	141.977	906.42	145.797	907.31
146.244	907.39	156.877	907.4	166.4	907.08	166.662	907.07	176.618	906.38
184.912	906.41	191.39	907.52	193.688	909.79	200.315	909.76	201.125	909
203.198	908.25	206.213	908.75	230.16	909.6	258.43	909.71	268.44	911.23
273.139	911.4	278.262	911.14	285.399	909.94	300.807	909.95	302.002	910.57
332.857	911								

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	62.394	.044	146.244	.08	156.877	.07	193.688	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
62.394	146.244	0	0	0	.1	.3

Left Levee Station= 49.31 Elevation= 913.584
Right Levee Station= 273.139 Elevation= 911.404

Profile Output Table - Standard Table 1

Reach	River Sta	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
d/s Grand Cache	14	810.00	916.240	920.848	918.877	921.06	0.001457	2.05	396.85	112.60	0.34
d/s Grand Cache	14	1100.00	916.240	921.631	919.309	921.90	0.001429	2.29	488.21	126.58	0.35
d/s Grand Cache	14	1320.00	916.240	922.147	919.608	922.45	0.001411	2.45	564.46	154.44	0.35
d/s Grand Cache	14	1380.00	916.240	922.279	919.682	922.59	0.001410	2.49	585.33	162.71	0.35
d/s Grand Cache	13	810.00	915.650	920.139	918.376	920.49	0.002274	2.61	310.21	80.87	0.43
d/s Grand Cache	13	1100.00	915.650	920.851	918.898	921.31	0.002433	2.99	368.61	83.42	0.45
d/s Grand Cache	13	1320.00	915.650	921.312	919.262	921.85	0.002545	3.24	414.87	103.79	0.47
d/s Grand Cache	13	1380.00	915.650	921.429	919.357	921.99	0.002572	3.31	427.07	104.48	0.47
d/s Grand Cache	12	810.00	915.220	919.286	917.754	919.61	0.002497	2.52	320.95	95.19	0.44
d/s Grand Cache	12	1100.00	915.220	919.959	918.230	920.37	0.002616	2.85	386.20	98.66	0.46
d/s Grand Cache	12	1320.00	915.220	920.400	918.560	920.88	0.002665	3.07	430.94	104.80	0.47
d/s Grand Cache	12	1380.00	915.220	920.510	918.648	921.01	0.002683	3.13	442.58	106.44	0.47
d/s Grand Cache	11.3	810.00	914.130	918.610	916.920	918.86	0.002012	2.23	369.01	118.08	0.38
d/s Grand Cache	11.3	1100.00	914.130	919.253	917.356	919.57	0.002159	2.52	447.55	125.26	0.40
d/s Grand Cache	11.3	1320.00	914.130	919.677	917.661	920.05	0.002268	2.72	501.52	132.42	0.41
d/s Grand Cache	11.3	1380.00	914.130	919.783	917.741	920.16	0.002301	2.77	515.56	133.79	0.41
d/s Grand Cache	11.2	Bridge									
d/s Grand Cache	11.1	810.00	914.130	918.563		918.82	0.001957	2.27	363.43	117.45	0.39
d/s Grand Cache	11.1	1100.00	914.130	919.187		919.53	0.002073	2.59	439.29	125.07	0.41
d/s Grand Cache	11.1	1320.00	914.130	919.591		919.99	0.002171	2.81	490.15	129.90	0.43
d/s Grand Cache	11.1	1380.00	914.130	919.692		920.11	0.002200	2.87	503.46	132.61	0.43
d/s Grand Cache	11	810.00	914.130	918.539		918.80	0.002003	2.28	360.62	117.14	0.40
d/s Grand Cache	11	1100.00	914.130	919.161		919.51	0.002119	2.61	436.01	125.25	0.42
d/s Grand Cache	11	1320.00	914.130	919.562		919.97	0.002221	2.83	487.21	132.15	0.43
d/s Grand Cache	11	1380.00	914.130	919.662		920.08	0.002251	2.89	500.73	136.72	0.44
d/s Grand Cache	10	810.00	913.380	917.763	916.163	917.95	0.001618	1.92	439.77	166.94	0.35
d/s Grand Cache	10	1100.00	913.380	918.395	916.529	918.62	0.001593	2.14	555.52	197.94	0.36

d/s Grand Cache	10	1320.00	913.380	918.796	916.790	919.05	0.001598	
2.29	636.67	205.40	0.36					
d/s Grand Cache	10	1380.00	913.380	918.896	916.860	919.16	0.001601	
2.33	657.22	205.93	0.36					
d/s Grand Cache	9.9	Bridge						
d/s Grand Cache	9.8	810.00	913.380	917.724		917.91	0.001689	
1.95	433.26	165.89	0.35					
d/s Grand Cache	9.8	1100.00	913.380	918.355		918.59	0.001653	
2.17	547.69	197.11	0.36					
d/s Grand Cache	9.8	1320.00	913.380	918.757		919.02	0.001656	
2.32	628.52	205.20	0.37					
d/s Grand Cache	9.8	1380.00	913.380	918.856		919.13	0.001657	
2.36	649.01	205.72	0.37					
d/s Grand Cache	9	810.00	912.310	916.636	915.323	917.03	0.003162	
2.79	290.41	99.81	0.49					
d/s Grand Cache	9	1100.00	912.310	917.096	915.815	917.65	0.003733	
3.30	356.89	187.68	0.54					
d/s Grand Cache	9	1320.00	912.310	917.394	916.155	918.04	0.004034	
3.61	415.92	204.01	0.57					
d/s Grand Cache	9	1380.00	912.310	917.470	916.242	918.14	0.004100	
3.69	431.48	204.32	0.58					
d/s Grand Cache	8	810.00	912.480	915.705	914.740	915.95	0.002793	
2.30	436.86	245.97	0.45					
d/s Grand Cache	8	1100.00	912.480	916.123	915.197	916.42	0.002913	
2.59	540.18	249.18	0.47					
d/s Grand Cache	8	1320.00	912.480	916.405	915.466	916.74	0.002982	
2.77	610.67	251.61	0.48					
d/s Grand Cache	8	1380.00	912.480	916.478	915.520	916.83	0.002997	
2.82	629.14	252.24	0.49					
d/s Grand Cache	7	810.00	910.630	914.512	913.437	914.68	0.002360	
1.95	524.32	301.48	0.40					
d/s Grand Cache	7	1100.00	910.630	914.940	913.899	915.14	0.002311	
2.15	653.58	302.62	0.41					
d/s Grand Cache	7	1320.00	910.630	915.236	914.134	915.46	0.002275	
2.28	743.42	303.42	0.41					
d/s Grand Cache	7	1380.00	910.630	915.312	914.181	915.54	0.002269	
2.32	766.54	303.62	0.41					
d/s Grand Cache	6	810.00	909.690	913.521	912.452	913.66	0.002544	
1.63	498.20	245.59	0.36					
d/s Grand Cache	6	1100.00	909.690	913.961	912.733	914.13	0.002523	
1.81	606.62	247.25	0.37					
d/s Grand Cache	6	1320.00	909.690	914.262	912.907	914.45	0.002516	
1.94	681.31	248.39	0.37					
d/s Grand Cache	6	1380.00	909.690	914.339	912.952	914.54	0.002520	
1.97	700.32	248.67	0.37					
d/s Grand Cache	5	810.00	907.980	912.711		912.89	0.002223	
2.21	571.91	356.07	0.41					
d/s Grand Cache	5	1100.00	907.980	913.180		913.38	0.002157	
2.40	748.12	395.18	0.41					
d/s Grand Cache	5	1320.00	907.980	913.514		913.72	0.002074	
2.50	884.53	422.98	0.41					
d/s Grand Cache	5	1380.00	907.980	913.595		913.81	0.002067	
2.53	919.02	429.79	0.41					
d/s Grand Cache	4	810.00	908.200	911.976	910.869	912.08	0.001936	
2.04	713.84	383.36	0.38					
d/s Grand Cache	4	1100.00	908.200	912.511	911.088	912.62	0.001725	
2.15	920.41	389.02	0.37					
d/s Grand Cache	4	1320.00	908.200	912.889	911.300	913.00	0.001600	
2.22	1067.66	390.64	0.36					
d/s Grand Cache	4	1380.00	908.200	912.971	911.347	913.08	0.001599	
2.25	1100.00	391.00	0.36					

d/s	Grand Cache	3	810.00	906.780	910.815		910.94	0.001485	
2.05	681.01	284.67	0.34						
d/s	Grand Cache	3	1100.00	906.780	911.442		911.58	0.001382	
2.20	860.27	286.79	0.34						
d/s	Grand Cache	3	1320.00	906.780	911.868		912.02	0.001336	
2.31	984.24	295.56	0.34						
d/s	Grand Cache	3	1380.00	906.780	911.926		912.08	0.001388	
2.37	1001.37	296.48	0.35						
d/s	Grand Cache	2	810.00	904.100	910.161	908.815	910.40	0.002078	
2.51	500.38	225.34	0.41						
d/s	Grand Cache	2	1100.00	904.100	910.830	909.456	911.08	0.001928	
2.66	651.83	227.33	0.40						
d/s	Grand Cache	2	1320.00	904.100	911.269	909.741	911.53	0.001859	
2.78	752.23	231.39	0.40						
d/s	Grand Cache	2	1380.00	904.100	911.384	909.809	911.61	0.001667	
2.67	892.07	293.44	0.38						
d/s	Grand Cache	1	810.00	905.310	909.545	908.038	909.78	0.002002	
2.34	419.60	156.79	0.40						
d/s	Grand Cache	1	1100.00	905.310	910.199	908.448	910.48	0.002003	
2.59	542.99	198.43	0.41						
d/s	Grand Cache	1	1320.00	905.310	910.630	908.732	910.95	0.002000	
2.75	629.34	202.30	0.41						
d/s	Grand Cache	1	1380.00	905.310	910.737	908.806	911.06	0.002001	
2.79	650.98	203.36	0.42						

APPENDIX B

100 Year Flood Risk Encroachment
HEC-RAS Input and Output Files

HEC-RAS Version 3.0.1 May 2002
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X     X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X       X
X     X  X        X    X       X   X     X    X       X
X     X  XXXXXX    XXXX        X    X    X    X   XXXXX
```

PROJECT DATA
Project Title: Smoky River Mine Flood Risk Study
Project File : SRM.prj
Run Date and Time: 05/03/04 2:56:04 PM

Project in SI units

Project Description:
Smoky River Coal Flood Risk Study

FLOW DATA

Flow Title: Q100 for Encroachment Run
Flow File : C:\Jobs\857 AENV SRC\HEC-RAS Input\SRM.f05

Flow Data (m3/s)

River	Reach	RS	No Encroachment	Encroachment
Smoky River	d/s Grand Cache	14	1320	1320

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Smoky River	d/s Grand Cache	No Encroachment		Normal S = .002
Smoky River	d/s Grand Cache	Encroachment		Normal S = .002

GEOMETRY DATA

Geometry Title: Section 1 - 14 (n = 0.044), Encroachment
Geometry File : C:\Jobs\857 AENV SRC\HEC-RAS Input\SRM.g01

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 14

INPUT
Description: Section 14
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	924.07	5.437	922.06	15.577	923.97	27.461	924.11	28.345	923.87
39.507	921.36	50.754	921.51	52.791	922.05	55.634	922.27	57.252	922.34
62.916	922.23	67.066	922.39	68.658	922.39	69.485	922.16	73.828	921.77

```
  84.436   921.6  94.047  921.75 101.955  921.55 108.546  917.94  111.41  916.73
  113.91  916.24 149.205  916.48 153.133   916.7 160.467  917.07 165.519  917.27
 166.851  917.68 169.776  917.26 175.837  916.96 180.686  917.17 181.636  917.37
 189.585  917.82 203.387  917.57 208.437  918.93 210.177  920.18 219.749  921.31
 224.137  922.16 237.634  922.37 258.885  923.98 284.471  926.04 301.154  928.46

Manning's n Values         num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  28.345     .08 101.955    .044 210.177      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       101.955 210.177              316     313     309             .1       .3
Left Levee      Station=  68.658      Elevation= 922.394

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 13

INPUT
Description: Section 13
Station Elevation Data    num=      36
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  930.56   7.997   928.9  23.553  920.31  25.823  920.36  27.617  921.11
  29.923  921.17   35.19     921  39.773  921.04  41.182  920.95  42.621  920.53
  46.748   917.6   48.37  916.63  56.007  915.65  65.226  915.69  75.254  915.69
  85.355  915.68  94.779  915.77 101.194  915.99 111.116   916.6 113.552  917.03
 120.956   917.7 125.625  921.39 145.905  923.48 163.749  925.59 186.099  928.31
 218.983  931.39  233.12  932.63 248.623   933.8 254.905  937.13 259.223  937.06
  263.52  937.63 267.948  936.97 268.807  936.74  269.57  937.07 276.243  937.44
 309.329  953.23

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  42.621    .044 125.625      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        42.621 125.625              387     365     347             .1       .3
Left Levee      Station=  29.923      Elevation= 921.204

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 12

INPUT
Description: Section 12
Station Elevation Data    num=      43
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  936.64  29.685  920.26  32.276  920.14  34.987  921.15  36.522  921.17
  38.228   921.1  38.839  920.96   43.13  920.87  49.055  920.92  50.863  920.92
  51.984  920.57  52.555  920.67  55.397  920.59  58.527  921.51   62.68  917.87
  64.154   916.9  67.918  915.94  79.854  915.28  88.429  915.87   99.34  915.65
 108.305  915.36 118.862  915.22 134.112  915.52 136.532  915.53 140.745  916.09
  151.16  917.02 152.816  918.43 159.117     920 172.818     921 193.246  922.01
 213.271  924.08 233.961  924.32 253.595  925.42 267.634  926.44 278.062   926.2
 283.058  930.04 288.004  930.01 293.002  929.81 295.901  927.79 303.558  927.95
 308.381  930.52 312.349  930.83 362.209  951.36

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  58.527    .044 159.117      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        58.527 159.117            329.5   325.5   325.5             .1       .3
Left Levee      Station=  58.527      Elevation= 921.514

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11.3

INPUT
Description: u/s end of road bridge (repeat of Section 11 + abutments)
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29   7.812  932.46  13.403  932.58  16.147  932.79  56.816 932.932
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  73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92  89.104  920.98
  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91  101.45  920.85
 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51 116.522  919.83
 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71 145.171  914.58
 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13 190.778  914.56
 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5 234.456  918.42
 242.599  919.13  250.44 925.678 270.918  924.53 278.946  924.58 287.487  924.54
 357.405     946

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 120.919    .044 234.456      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       116.522 222.803              6.5     6.5     6.5             .1       .3

BRIDGE                  RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11.2

INPUT
Description: Road Bridge
Distance from Upstream XS =      .09
Deck/Roadway Width        =     6.3
Weir Coefficient          =    1.44
Upstream  Deck/Roadway Coordinates
    num=       18
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  56.816  932.93  932.93  60.245   932.8  931.28  71.675  932.37  930.84
  78.533  932.11  930.58  86.153  931.82  930.29  90.725  931.64  930.12
 108.404  930.97  929.45 118.767  930.58  929.06 121.815  930.46  928.94
 146.808  929.51  927.99 171.802  928.56  927.04 196.796  927.62  926.09
 221.789  926.67  925.14 227.504  926.45  924.92 232.457  926.26  924.74
 233.981   926.2  924.68 246.783  925.72  924.19  250.44  925.68  925.68

Upstream Bridge Cross Section Data
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29   7.812  932.46  13.403  932.58  16.147  932.79  56.816 932.932
  73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92  89.104  920.98
  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91  101.45  920.85
 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51 116.522  919.83
 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71 145.171  914.58
 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13 190.778  914.56
 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5 234.456  918.42
 242.599  919.13  250.44 925.678 270.918  924.53 278.946  924.58 287.487  924.54
 357.405     946

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 120.919    .044 234.456      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       116.522 222.803             .1       .3

Downstream  Deck/Roadway Coordinates
    num=       18
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  56.816  932.93  932.93  60.245   932.8  931.28  71.675  932.37  930.84
  78.533  932.11  930.58  86.153  931.82  930.29  90.725  931.64  930.12
 108.404  930.97  929.45 118.767  930.58  929.06 121.815  930.46  928.94
 146.808  929.51  927.99 171.802  928.56  927.04 196.796  927.62  926.09
 221.789  926.67  925.14 227.504  926.45  924.92 232.457  926.26  924.74
 233.981   926.2  924.68 246.783  925.72  924.19  250.44  925.68  925.68

Downstream Bridge Cross Section Data
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29   7.812  932.46  13.403  932.58  16.147  932.79  56.816 932.932
  73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92  89.104  920.98
  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91  101.45  920.85
 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51 116.522  919.83
```

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 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71 145.171  914.58
 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13 190.778  914.56
 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5 234.456  918.42
 242.599  919.13  250.44 925.678 270.918  924.53 278.946  924.58 287.487  924.54
 357.405     946

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 116.522    .044 222.803      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       116.522 222.803             .1       .3

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Piers =  6

Pier Data
Pier Station     Upstream=  78.534    Downstream=  78.534
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  922.71     1.5  923.85      .9  923.85      .9  930.58
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  922.71     1.5  923.85      .9  923.85      .9  930.58

Pier Data
Pier Station     Upstream= 121.815    Downstream= 121.815
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  916.61     1.5   920.8      .9   920.8      .9  928.94
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  916.61     1.5   920.8      .9   920.8      .9  928.94

Pier Data
Pier Station     Upstream= 146.809    Downstream= 146.809
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  915.09     1.5  919.89      .9  919.89      .9  927.99
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  915.09     1.5  919.89      .9  919.89      .9  927.99

Pier Data
Pier Station     Upstream= 171.802    Downstream= 171.802
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  913.94     1.5  919.89      .9  919.89      .9  927.04
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  913.94     1.5  919.89      .9  919.89      .9  927.04

Pier Data
Pier Station     Upstream= 196.796    Downstream= 196.796
Upstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  915.09     1.5  919.89      .9  919.89      .9  926.09
Downstream     num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      1.5  915.09     1.5  919.89      .9  919.89      .9  926.09

Pier Data
Pier Station     Upstream=  221.79    Downstream=  221.79
Upstream     num=       4
```

```
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
     1.5  916.76     1.5  919.89      .9  919.89      .9  925.14
Downstream     num=        4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
     1.5  916.76     1.5  919.89      .9  919.89      .9  925.14

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11.1

INPUT
Description: d/s end of road bridge (repeat of Section 11 + abutments)
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29   7.812  932.46  13.403  932.58  16.147  932.79  56.816 932.932
  73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92  89.104  920.98
  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91  101.45  920.85
 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51 116.522  919.83
 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71 145.171  914.58
 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13 190.778  914.56
 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5 234.456  918.42
 242.599  919.13  250.44 925.678 270.918  924.53 278.946  924.58 287.487  924.54
 357.405     946

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 116.522    .044 222.803      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       116.522 222.803               10      10      10             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 11

INPUT
Description: Section 11 (10 m d/s of road bridge)
Station Elevation Data    num=      42
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  932.29   7.812  932.46  13.403  932.58  16.147  932.79  20.286  931.71
  42.044  928.85  73.062  922.66  77.402  920.86  79.915  920.65  81.133  920.92
  89.104  920.98  90.672  920.99  91.284  920.85  95.429  920.82 100.174  920.91
  101.45  920.85 102.453   920.5  108.14  920.22  109.49  919.63 114.025  919.51
 116.522  919.83 120.919   917.2 122.619  916.42 128.763  915.51 136.324  914.71
 145.171  914.58 155.303  914.39 162.977  914.63 172.078   914.7 183.857  914.13
 190.778  914.56 195.711  915.49 218.267  916.04 219.975  916.41 222.803   917.5
 234.456  918.42 242.599  919.13 262.642  921.21 270.918  924.53 278.946  924.58
 287.487  924.54 357.405     946

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 116.522    .044 222.803      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       116.522 222.803               454     464     463             .1       .3

CROSS SECTION          RIVER: Smoky River
```

REACH: d/s Grand Cache RS: 10

INPUT
Description: Section 10 (10 m u/s of conveyor bridge)
Station Elevation Data num= 58

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	934.25	17.643	929.5	37.169	923.9	54.341	923.37	58.616	920.46
61.383	920.39	64.153	921.52	67.986	921.33	73.49	921.26	78.422	919.48
98.512	919.6	118.193	919.25	138.275	919.04	156.498	919.04	176.621	919.02
194.961	919.24	213.648	919.2	232.11	919.31	250.513	919.22	268.085	919.33
286.051	919.3	304.81	919.09	324.443	919.46	328.775	919.2	342.616	919.6
354.711	919.55	359.317	919.4	362.534	919.27	365.306	919.28	369.93	916.26
392.857	917.44	394.332	917.63	399.971	918.3	402.402	917.87	406.382	918.04
409.873	917.98	420.114	918.74	425.336	916.21	431.704	915.88	438.429	914.74
447.285	914.35	457.649	914.55	468.944	914.82	473.979	914.93	492.316	915.21
505.306	915.04	517.941	914.09	527.968	913.38	554.325	914.1	554.732	914.94
555.897	917.4	569.758	918.34	579.359	920.93	583.624	921.14	590.788	921.15
610.25	921.93	634.989	923.99	660.47	927.24				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	365.306	.075	420.114	.044	555.897	.075	579.359	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
420.114	555.897	16	16	.1	.3

Left Levee Station= 342.616 Elevation= 919.604

BRIDGE RIVER: Smoky River
REACH: d/s Grand Cache RS: 9.9

INPUT
Description: Conveyor Bridge
Distance from Upstream XS = 10
Deck/Roadway Width = 6
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 4

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
414.13	919.73	919.63	508.13	920.3	920.2	554.73	920.74	920.64
579.36	921.04	920.94						

Upstream Bridge Cross Section Data
Station Elevation Data num= 58

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	934.25	17.643	929.5	37.169	923.9	54.341	923.37	58.616	920.46
61.383	920.39	64.153	921.52	67.986	921.33	73.49	921.26	78.422	919.48
98.512	919.6	118.193	919.25	138.275	919.04	156.498	919.04	176.621	919.02
194.961	919.24	213.648	919.2	232.11	919.31	250.513	919.22	268.085	919.33
286.051	919.3	304.81	919.09	324.443	919.46	328.775	919.2	342.616	919.6
354.711	919.55	359.317	919.4	362.534	919.27	365.306	919.28	369.93	916.26
392.857	917.44	394.332	917.63	399.971	918.3	402.402	917.87	406.382	918.04
409.873	917.98	420.114	918.74	425.336	916.21	431.704	915.88	438.429	914.74
447.285	914.35	457.649	914.55	468.944	914.82	473.979	914.93	492.316	915.21
505.306	915.04	517.941	914.09	527.968	913.38	554.325	914.1	554.732	914.94
555.897	917.4	569.758	918.34	579.359	920.93	583.624	921.14	590.788	921.15
610.25	921.93	634.989	923.99	660.47	927.24				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	365.306	.075	420.114	.044	555.897	.075	579.359	.1

Bank Sta: Left	Right	Coeff Contr.	Expan.
420.114	555.897	.1	.3

Left Levee Station= 342.616 Elevation= 919.604

Downstream Deck/Roadway Coordinates
num= 4

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
414.13	919.73	919.63	508.13	920.3	920.2	554.73	920.74	920.64
579.36	921.04	920.94						

```
Downstream Bridge Cross Section Data
Station Elevation Data    num=      58
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  934.25  17.643   929.5  37.169   923.9  54.341  923.37  58.616  920.46
  61.383  920.39  64.153  921.52  67.986  921.33   73.49  921.26  78.422  919.48
  98.512   919.6 118.193  919.25 138.275  919.04 156.498  919.04 176.621  919.02
 194.961  919.24 213.648   919.2  232.11  919.31 250.513  919.22 268.085  919.33
 286.051   919.3  304.81  919.09 324.443  919.46 328.775   919.2 342.616   919.6
 354.711  919.55 359.317   919.4 362.534  919.27 365.306  919.28  369.93  916.26
 392.857  917.44 394.332  917.63 399.971   918.3 402.402  917.87 406.382  918.04
 409.873  917.98 420.114  918.74 425.336  916.21 431.704  915.88 438.429  914.74
 447.285  914.35 457.649  914.55 468.944  914.82 473.979  914.93 492.316  915.21
 505.306  915.04 517.941  914.09 527.968  913.38 554.325   914.1 554.732  914.94
 555.897   917.4 569.758  918.34 579.359  920.93 583.624  921.14 590.788  921.15
  610.25  921.93 634.989  923.99  660.47  927.24

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 365.306    .075 420.114    .044 555.897    .075 579.359      .1

Bank Sta: Left   Right    Coeff Contr.   Expan.
       420.114 555.897             .1       .3

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Piers =  3

Pier Data
Pier Station     Upstream= 415.982    Downstream= 415.982
Upstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      3.7  918.4      3.7  919.1       .9  919.1       .9 919.63
Downstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
      3.7  918.4      3.7  919.1       .9  919.1       .9 919.63

Pier Data
Pier Station     Upstream= 508.132    Downstream= 508.132
Upstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
        4 914.6         4 915.4       .9 915.4       .9  920.2
Downstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
        4 914.6         4 915.4       .9 915.4       .9  920.2

Pier Data
Pier Station     Upstream= 554.732    Downstream= 554.732
Upstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
        3 914.2         3    915       .6    915       .6 920.64
Downstream      num=       4
    Width   Elev    Width   Elev    Width   Elev    Width   Elev
        3 914.2         3    915       .6    915       .6 920.64

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Energy

High Flow Method
       Energy

Additional Bridge Parameters
       Add Friction component to Momentum
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```
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 9.8

INPUT
Description: d/s end of conveyor bridge (repeat of Section 10)
Station Elevation Data    num=      58
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  934.25  17.643   929.5  37.169   923.9  54.341  923.37  58.616  920.46
  61.383  920.39  64.153  921.52  67.986  921.33   73.49  921.26  78.422  919.48
  98.512   919.6 118.193  919.25 138.275  919.04 156.498  919.04 176.621  919.02
 194.961  919.24 213.648   919.2  232.11  919.31 250.513  919.22 268.085  919.33
 286.051   919.3  304.81  919.09 324.443  919.46 328.775   919.2 342.616   919.6
 354.711  919.55 359.317   919.4 362.534  919.27 365.306  919.28  369.93  916.26
 392.857  917.44 394.332  917.63 399.971   918.3 402.402  917.87 406.382  918.04
 409.873  917.98 420.114  918.74 425.336  916.21 431.704  915.88 438.429  914.74
 447.285  914.35 457.649  914.55 468.944  914.82 473.979  914.93 492.316  915.21
 505.306  915.04 517.941  914.09 527.968  913.38 554.325   914.1 554.732  914.94
 555.897   917.4 569.758  918.34 579.359  920.93 583.624  921.14 590.788  921.15
  610.25  921.93 634.989  923.99  660.47  927.24

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 365.306    .075 420.114    .044 555.897    .075 579.359      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       420.114 555.897              386     382     395             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 9

INPUT
Description: Section 9
Station Elevation Data    num=      52
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  928.12    6.55  925.71   34.08  924.65   57.33  923.76   66.92  920.69
   69.61  918.24   71.38   918.2   75.22  919.46   95.52   919.4  118.05   918.2
   142.2  918.61  171.79  918.64  192.63  918.66  209.99  918.69  212.58  918.74
  214.39  918.73   238.1  918.28   263.5  918.04  281.92  917.87  282.79   917.6
  285.95  917.52  286.62  918.05  292.44  917.97   321.8  917.88  323.11  917.85
  324.62  917.39  326.54  917.36   328.5  917.36  333.24  916.94  354.09  916.74
  372.59  917.15  388.91  917.02  410.84  916.71  425.76  916.55  440.01  916.84
  443.81  914.56   445.8  913.61  457.26  912.31  470.24  912.45  473.76  912.65
  482.21   913.1  490.31  913.27   498.8  913.54  505.41  913.63  507.43  913.74
  513.98  913.78  519.44  913.53  523.69  913.75  523.71  913.76  526.18  914.41
     528  916.64   537.5  928.28

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  323.11    .075  440.01    .044     528      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        440.01     528              361     349     338             .1       .3
Left Levee      Station=  286.62      Elevation= 918.054

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 8

INPUT
Description: Section 8
Station Elevation Data    num=      54
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  930.77  10.556  926.07  37.983  922.16  40.828  920.79  42.857  920.72
  44.943  920.88  50.093  920.62  53.658  920.49  70.123  919.11  89.495  918.12
 109.118  917.62 138.077  917.11 139.983     917  143.06  917.07  145.28  915.87
 152.632  915.96 153.224  916.22 161.431  916.47 174.454  916.72 179.537  916.94
 183.894  917.09 189.089  917.02 190.487  916.98 191.076  916.73  192.36  916.67
```

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 194.414   916.6 198.267  915.06 211.421  914.24 219.103  914.32 269.974  914.85
 296.092  914.96 313.509  915.14 324.342  915.23 326.557   914.1 327.093  913.61
  331.87  913.73  335.83  913.62 339.426  913.19 350.249  912.91 363.705  912.84
 375.787   912.8  390.97  912.78 405.073  912.48 408.592  912.57 416.152  912.75
 423.697  912.93 429.989  913.17 433.699  913.15 440.469  914.08 442.738  915.79
 451.766  917.26 484.386   939.5  484.96  939.18 496.485  938.96

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 198.267    .075 324.342    .044 442.738      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       324.342 442.738              425     495     512             .1       .3
Left Levee      Station= 183.894      Elevation= 917.024

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 7

INPUT
Description: Section 7
Station Elevation Data    num=      51
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  928.67    3.36   926.9  11.461  926.36  30.312  914.08 167.245   913.7
 171.025  915.41 175.594  915.78 188.462  916.25 193.584  916.28 202.726  916.37
 205.995  916.16 209.276  916.06 213.838  913.79  235.78     914 267.314   913.5
 289.239  913.15 290.112  912.58 290.264  911.94 308.701  911.95 309.993  912.57
 315.532  912.46 316.949  913.28 317.767   913.5 342.581  913.73 365.673  913.76
  367.65  912.59 368.964  911.77 372.768  911.43 374.939  911.46 376.227  911.95
  384.04  912.18 398.053  912.67 405.288  912.62 413.105   912.4 420.367   912.6
 423.985  913.25 427.939  913.17 439.358  913.07 443.907  912.88 455.008  912.52
 463.334  911.97 472.907  911.51 483.483  911.31 492.735  910.63 503.324  910.69
 511.799  912.09 513.307  913.65 514.658  915.71 535.524  917.68 551.617   921.8
 558.928  925.42

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 213.838    .075 365.673    .044 514.658      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       365.673 514.658              433     413     324             .1       .3
Left Levee      Station= 202.726      Elevation= 916.374

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 6

INPUT
Description: Section 6
Station Elevation Data    num=      60
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  941.03  36.586  926.46  72.903  919.01   80.09  915.57  84.486  913.62
  92.483  913.64  94.304  914.47   96.57  914.43  97.368  914.75  98.959  914.71
  108.57   914.7   110.2  915.05 111.499  915.03 113.816  914.98 114.953   915.3
 116.394  915.29 120.626  915.36 125.277  915.41 126.708  915.36 127.469  915.02
 128.582  914.95 130.733  914.86 136.233  912.65 138.806  912.01 139.192  911.56
 139.541  911.52  140.02  911.92 157.675  912.98 158.522  912.48  160.02  911.84
  164.13  912.13 177.996  910.54 184.773  910.05 194.169  909.69 205.851  910.58
 215.432  911.32 226.784  911.88 235.056  912.14 245.785  912.42 265.115  912.61
 267.066  912.48 271.903  910.92 286.626  910.08 299.195  910.39 321.637  910.98
 333.577   912.1  356.16  912.16 372.686  912.19 377.284  911.89 378.705  912.78
 381.346  914.84 395.703  915.78 458.451  920.01 471.461  924.17 499.135  925.65
 518.804  928.84 522.494  930.69 525.976  930.51 526.676  930.23 538.283   930.4

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 130.733    .044 226.784    .075 267.066    .055 381.346      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       130.733 381.346              337     322     302             .1       .3
Left Levee      Station= 125.277      Elevation= 915.414

CROSS SECTION          RIVER: Smoky River
```

REACH: d/s Grand Cache RS: 5

INPUT
Description: Section 5
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	911.76	7.142	914.49	8.714	914.53	14.614	914.74	17.734	914.72
19.05	914.66	23.11	914.03	28.252	911.76	44.41	911.6	63.187	911.99
80.798	911.83	97.838	912	137.199	912.12	147.26	913.58	152.936	914.07
163.41	913.76	170.61	912.44	171.512	911.61	174.158	910.82	179.353	911.47
183.533	910.22	194.654	907.98	205.312	908.98	216.583	909.36	223.573	909.5
229.065	909.38	243.774	910.43	252.383	910.95	259.672	910.43	279.872	911.26
297.665	911.45	314.848	910.98	331.802	911.13	348.708	911.27	361.484	910.46
367.167	909.91	377.314	910.49	385.835	911.93	386.958	912.4	470.305	913.66
483.268	919.74	483.867	919.77	495.554	919.78				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	170.61	.044	252.383	.075	348.708	.06	385.835	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
170.61	252.383	375	377	390	.1	.3

Left Levee Station= 14.614 Elevation= 914.74

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 4

INPUT
Description: Section 4
Station Elevation Data num= 57

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	933.24	27.836	913.11	29.506	913.78	30.992	913.79	35.69	913.87
37.099	913.86	40.03	913.38	42.511	912.35	46.628	912.06	50.335	909.82
55.232	908.78	58.028	909.43	61.829	910.46	80.847	910.84	112.349	910.78
146.408	911.05	164.18	911.25	187.605	911.15	193.4	911.27	195.016	910.07
195.769	909.9	198.79	908.93	199.823	908.58	205.904	908.2	216.233	908.38
217.918	908.89	231.42	910.16	265.674	909.84	279.665	909.58	287.389	909.33
292.692	909.18	295.426	909.75	300.728	909.51	307.679	908.95	313.992	908.67
317.5	908.43	324.553	908.21	329.628	908.25	335.697	908.53	345.859	909.54
350.111	910.1	351.174	910.66	366.364	911	378.301	910.9	393.549	910.89
407.08	910.85	409.911	909.78	411.406	909.23	411.988	909.12	418.942	907.97
423.852	909.12	424.379	909.19	428.639	911.23	429.529	911.66	453.046	924.07
459.433	924.59	461.029	925.19						

Manning's n Values num= 8

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.1	46.628	.075	61.829	.08	193.4	.044	231.42	.07
350.111	.08	407.08	.075	428.639	.1				

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
193.4	231.42	660	669	680	.1	.3

Left Levee Station= 193.4 Elevation= 911.272
Right Levee Station= 366.364 Elevation= 911.004

CROSS SECTION RIVER: Smoky River
REACH: d/s Grand Cache RS: 3

INPUT
Description: Section 3
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	919.23	12.736	911.66	16.46	911.48	19.199	912.43	21.081	912.41
22.925	912.3	29.593	911.6	33.225	909.22	38.481	907.47	58.524	907.34
60.605	907.94	78.25	908.49	91.632	908.31	93.901	908.05	96.097	908.26
104.381	908.27	120.463	907.89	123.098	907.68	131.152	906.99	136.429	906.97
142.858	906.84	149.822	906.78	155.72	906.83	169.75	907.65	173.137	908.95
173.435	909.5	174.959	909.62	186.752	909.98	201.521	909.35	202.594	909.66
202.662	909.69	210.077	909.73	226.206	908.65	245.149	908.93	272.887	909.5
284.417	909.16	285.448	908.66	293.589	908.52	298.293	907.67	310.215	907.85
312.023	908.42	312.217	909.06	342.659	925.51				

```
Manning's n Values          num=        7
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  33.225    .075  60.605     .08 120.463    .044 173.435     .08
 293.589    .075 312.217      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       120.463 173.435               329     310     277             .1       .3

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 2

INPUT
Description: Section 2
Station Elevation Data     num=       39
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   934.05   47.29   909.13   68.234   909.29   95.832   909.44 101.615    911.1
 104.512   911.29 105.952   911.21 108.422   910.82 113.385   907.57 115.625   906.67
 122.137    904.1 126.563   904.55 132.316   905.72 146.729   906.31 155.534   906.66
 164.697   907.45 166.661   908.14 168.369   908.08   179.94   908.79 188.878   908.91
 193.258   907.57 195.764   907.48 201.438   909.12 216.344   909.26 233.226   909.37
 254.394   908.95 270.249   908.86 274.696   908.19 283.844   908.63 302.766   908.27
 303.211   907.66 303.925    907.3 312.112   907.23 318.042   907.01 325.075    907.1
 329.563   906.77 331.748   907.48 332.208    908.3 349.848   921.12

Manning's n Values          num=        5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1 108.422    .044 166.661     .08 302.766     .07 332.208      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       108.422 166.661               258     300     300             .1       .3
Left Levee      Station= 104.512      Elevation= 911.293

CROSS SECTION          RIVER: Smoky River
REACH: d/s Grand Cache    RS: 1

INPUT
Description: Section 1
Station Elevation Data     num=       46
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   916.46   13.551   909.52    15.42   909.52   17.321   910.33   21.267   910.68
  23.121    910.7   27.672   909.53   30.613   909.51    34.77   912.04    49.31   913.58
  55.289   912.69   62.394   910.57   68.533   907.84   70.979   906.68   84.286    906.2
  98.929   905.45 106.952    905.4 113.743   905.45 118.877   905.47 124.607   905.48
  132.12   905.31 138.088   906.22 139.611   906.49 141.977   906.42 145.797   907.31
 146.244   907.39 156.877    907.4    166.4   907.08 166.662   907.07 176.618   906.38
 184.912   906.41   191.39   907.52 193.688   909.79 200.315   909.76 201.125      909
 203.198   908.25 206.213   908.75   230.16    909.6   258.43   909.71   268.44   911.23
 273.139    911.4 278.262   911.14 285.399   909.94 300.807   909.95 302.002   910.57
 332.857      911

Manning's n Values          num=        5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  62.394    .044 146.244     .08 156.877     .07 193.688      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        62.394 146.244                 0       0       0             .1       .3
Left Levee      Station=   49.31      Elevation= 913.584
Right Levee     Station= 273.139      Elevation= 911.404

Profile Output Table - Standard Table 1

  Reach          River Sta          Q Total  Min Ch El  W.S. Elev  Crit W.S.  E.G. Elev  E.G. Slope
Vel Chnl  Flow Area  Top Width  Froude # Chl
                                    (m3/s)         (m)        (m)         (m)        (m)        (m/m)
(m/s)        (m2)         (m)

  d/s Grand Cache  14                1320.00    916.240    922.147    919.608     922.45    0.001411
2.45     564.46     154.44          0.35
  d/s Grand Cache  14                1320.00    916.240    922.155    919.608     922.46    0.001411
2.45     550.99     121.00          0.35
```

d/s Grand Cache	13	1320.00	915.650	921.312	919.262	921.85	0.002545
3.24	414.87	103.79	0.47				
d/s Grand Cache	13	1320.00	915.650	921.322	919.262	921.86	0.002537
3.24	407.34	82.92	0.47				
d/s Grand Cache	12	1320.00	915.220	920.400	918.560	920.88	0.002665
3.07	430.94	104.80	0.47				
d/s Grand Cache	12	1320.00	915.220	920.423	918.560	920.90	0.002620
3.05	432.14	99.35	0.47				
d/s Grand Cache	11.3	1320.00	914.130	919.677	917.661	920.05	0.002268
2.72	501.52	132.42	0.41				
d/s Grand Cache	11.3	1320.00	914.130	919.716		920.08	0.002215
2.70	499.87	119.29	0.41				
d/s Grand Cache	11.2	Bridge					
d/s Grand Cache	11.1	1320.00	914.130	919.591		919.99	0.002171
2.81	490.15	129.90	0.43				
d/s Grand Cache	11.1	1320.00	914.130	919.639		920.03	0.002099
2.79	490.71	119.16	0.42				
d/s Grand Cache	11	1320.00	914.130	919.562		919.97	0.002221
2.83	487.21	132.15	0.43				
d/s Grand Cache	11	1320.00	914.130	919.612		920.01	0.002141
2.80	487.54	119.11	0.43				
d/s Grand Cache	10	1320.00	913.380	918.796	916.790	919.05	0.001598
2.29	636.67	205.40	0.36				
d/s Grand Cache	10	1320.00	913.380	918.910	916.790	919.15	0.001450
2.22	655.96	198.90	0.35				
d/s Grand Cache	9.9	Bridge					
d/s Grand Cache	9.8	1320.00	913.380	918.757		919.02	0.001656
2.32	628.52	205.20	0.37				
d/s Grand Cache	9.8	1320.00	913.380	918.875		919.12	0.001494
2.24	649.00	198.90	0.35				
d/s Grand Cache	9	1320.00	912.310	917.394	916.155	918.04	0.004034
3.61	415.92	204.01	0.57				
d/s Grand Cache	9	1320.00	912.310	917.404	916.185	918.15	0.004609
3.82	345.79	83.69	0.60				
d/s Grand Cache	8	1320.00	912.480	916.405	915.466	916.74	0.002982
2.77	610.67	251.61	0.48				
d/s Grand Cache	8	1320.00	912.480	916.405	915.466	916.74	0.002983
2.77	609.53	247.84	0.48				
d/s Grand Cache	7	1320.00	910.630	915.236	914.134	915.46	0.002274
2.28	743.46	303.42	0.41				
d/s Grand Cache	7	1320.00	910.630	915.236	914.134	915.46	0.002274
2.28	743.48	303.42	0.41				
d/s Grand Cache	6	1320.00	909.690	914.264	912.907	914.45	0.002512
1.94	681.59	248.39	0.37				
d/s Grand Cache	6	1320.00	909.690	914.264	912.907	914.46	0.002511
1.94	681.70	248.39	0.37				
d/s Grand Cache	5	1320.00	907.980	913.514	912.344	913.72	0.002078
2.50	880.48	418.38	0.41				
d/s Grand Cache	5	1320.00	907.980	913.513	912.344	913.73	0.002078
2.50	872.32	385.74	0.41				
d/s Grand Cache	4	1320.00	908.200	912.888	911.300	913.00	0.001601
2.22	1067.48	390.64	0.36				
d/s Grand Cache	4	1320.00	908.200	912.889	911.300	913.00	0.001600
2.22	1067.72	390.64	0.36				
d/s Grand Cache	3	1320.00	906.780	911.866		912.01	0.001338
2.31	983.82	295.54	0.34				

d/s Grand Cache	3	1320.00	906.780	911.868		912.02	0.001336	
2.31	982.73	288.80	0.34					
d/s Grand Cache	2	1320.00	904.100	911.266	909.742	911.53	0.001863	
2.78	751.62	231.34	0.40					
d/s Grand Cache	2	1320.00	904.100	911.269	909.732	911.53	0.001859	
2.78	751.58	227.89	0.40					
d/s Grand Cache	1	1320.00	905.310	910.630	908.731	910.95	0.002000	
2.75	629.34	202.30	0.41					
d/s Grand Cache	1	1320.00	905.310	910.630	908.724	910.95	0.002000	
2.75	629.34	202.30	0.41					

1. Cross section #1 left bank to right.

2. Cross section #2 left bank to right.

3. Cross section #3 left bank to right.

4. Cross section #4 left bank to right.

5. Cross section #4 left bank looking NW.

6. Cross section #4 left to right from tracks.

7. Cross section #5 left bank to right.

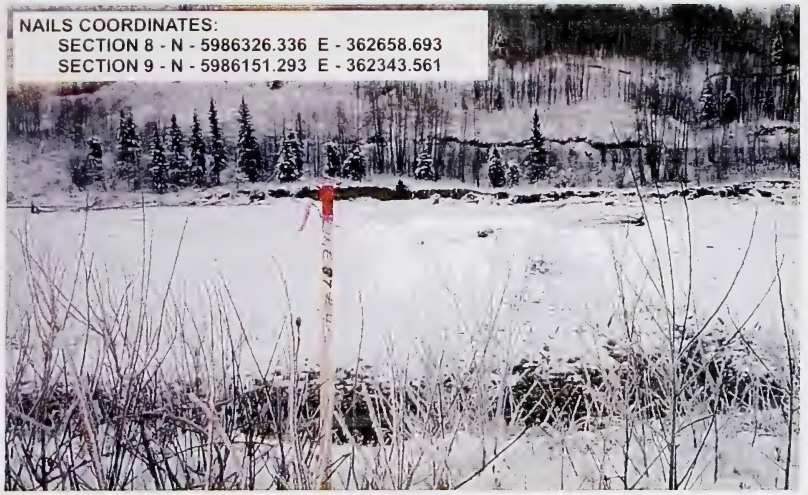
8. Cross section #5 left bank looking NW.

9. Cross section #6 left bank to right.

10. Cross section #6 left bank looking NW.

11. Cross section #6 left bank looking NW.

12. Cross section #7 left bank looking NW.



13. Cross section #7 left bank to right.

14. Cross section #8 left bank looking NW

15. Cross section #8 left bank looking NW

16. Looking across the Smoky River from the top of left bank at Section #8.

17. Cross section #8 left bank to right.

18. Looking NW from top of left bank to plant site along Section #9.

19. Standing at top of left bank at Section #9. Looking across the Smoky River.

20. Cross section #10 left bank looking NW.

21. Cross section #10 left bank to right.

22. Cross section #11 left bank to right.

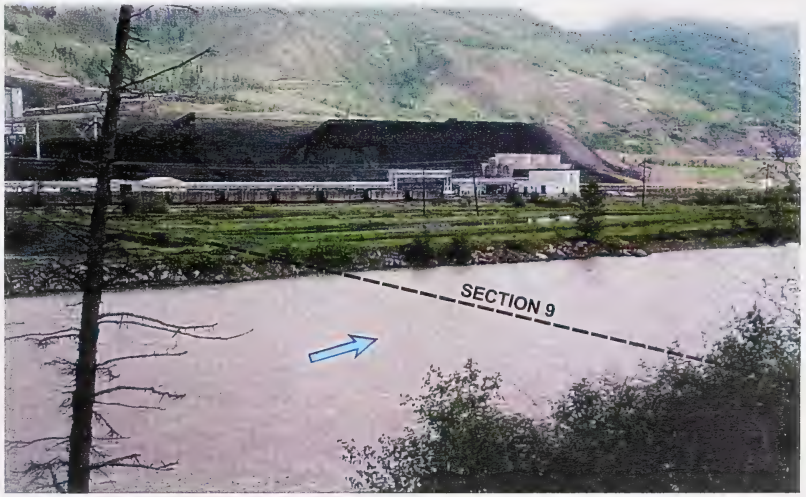
23. Cross section #12 left bank to right.

24. Cross section #13 left bank looking NW

25. Cross section #13 left bank to right.

26. Cross section #14 left bank to right.

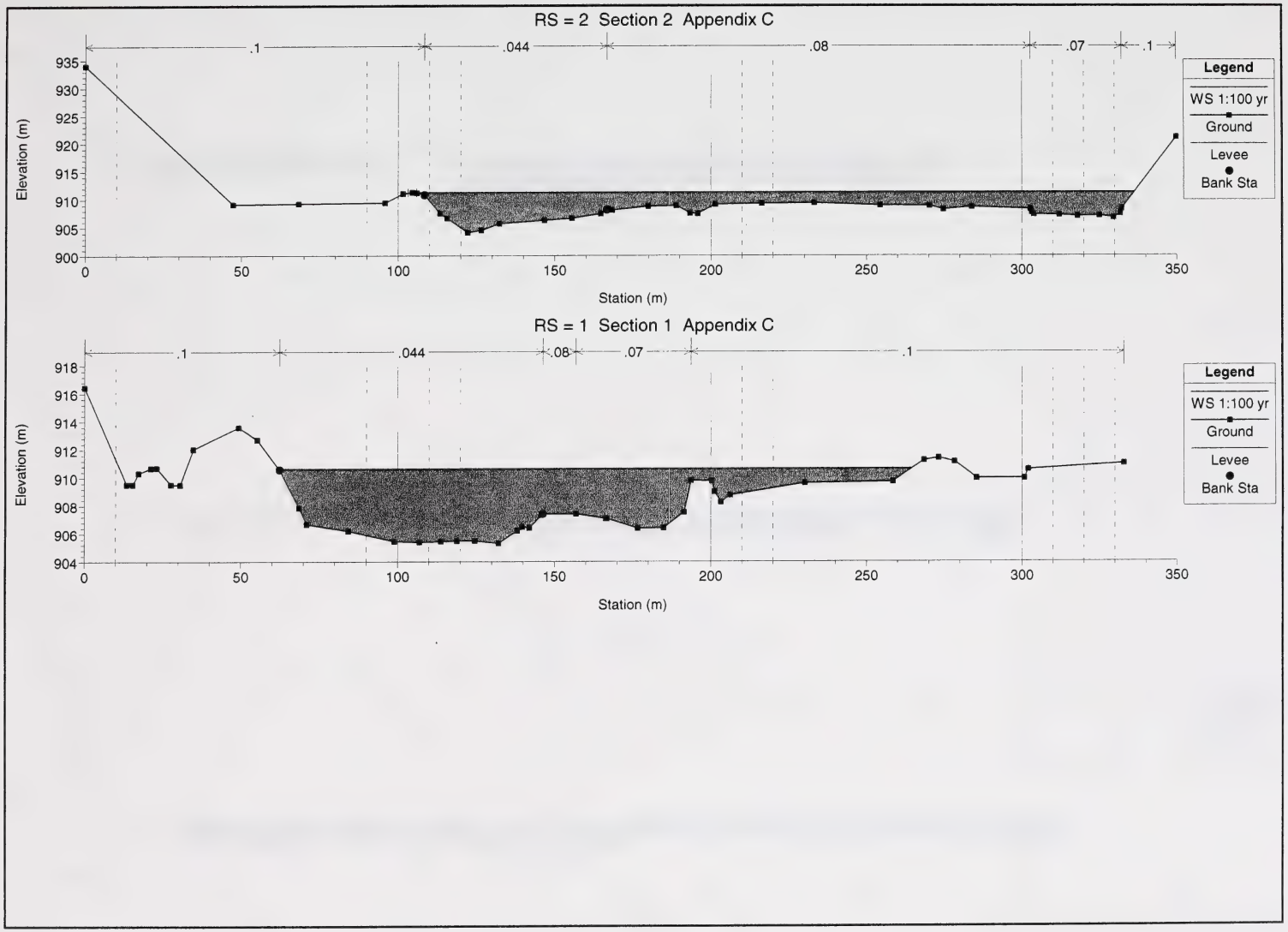
27. May 1998, looking at H.R. Milner Plant Site in background from top of right bank between Sections 9 and 10. Discharge 191 m³/s.



28. May 1998, looking at SRC Plant Site settling ponds. Discharge 191 m³/s.

29. September 23, 1998. Smoky River Road Bridge. Note the debris on piers. Discharge 47.2 m³/s.

30. July 18, 2001. Smoky River Road Bridge at approximately 10:00 am. Discharge peaked at 4:25 pm at 810 m³/s. Estimated discharge at time of photo 660 m³/s. Top of pier #3 elevation is 919.89 m.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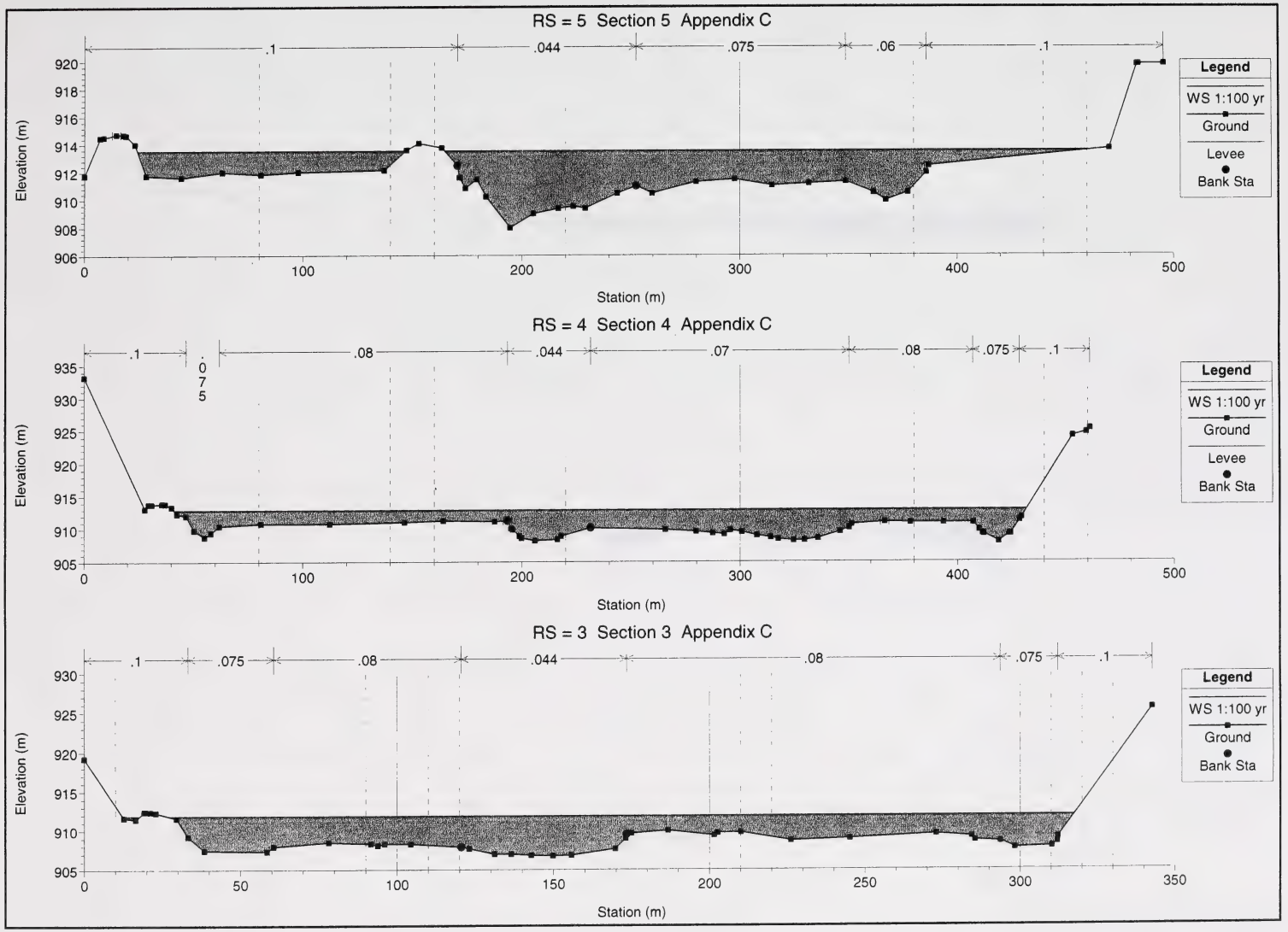
.044
.08
.07
.1
Elevation (m)
935
930
925
920
915
910
905
900
0
50
100
150
200
250
300
350
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 1 Section 1 Appendix C
.1
.044
.08
.07
.1
Elevation (m)
918
916
914
912
910
908
906
904
0
50
100
150
200
250
300
350
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta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.044
.075
.06
.1
Elevation (m)
920
918
916
914
912
910
908
906
0
100
200
300
400
500
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 4 Section 4 Appendix C
.1
.075
.08
.044
.07
.08
.075
.1
Elevation (m)
935
930
925
920
915
910
905
0
100
200
300
400
500
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 3 Section 3 Appendix C
.1
.075
.08
.044
.08
.075
.1
Elevation (m)
930
925
920
915
910
905
0
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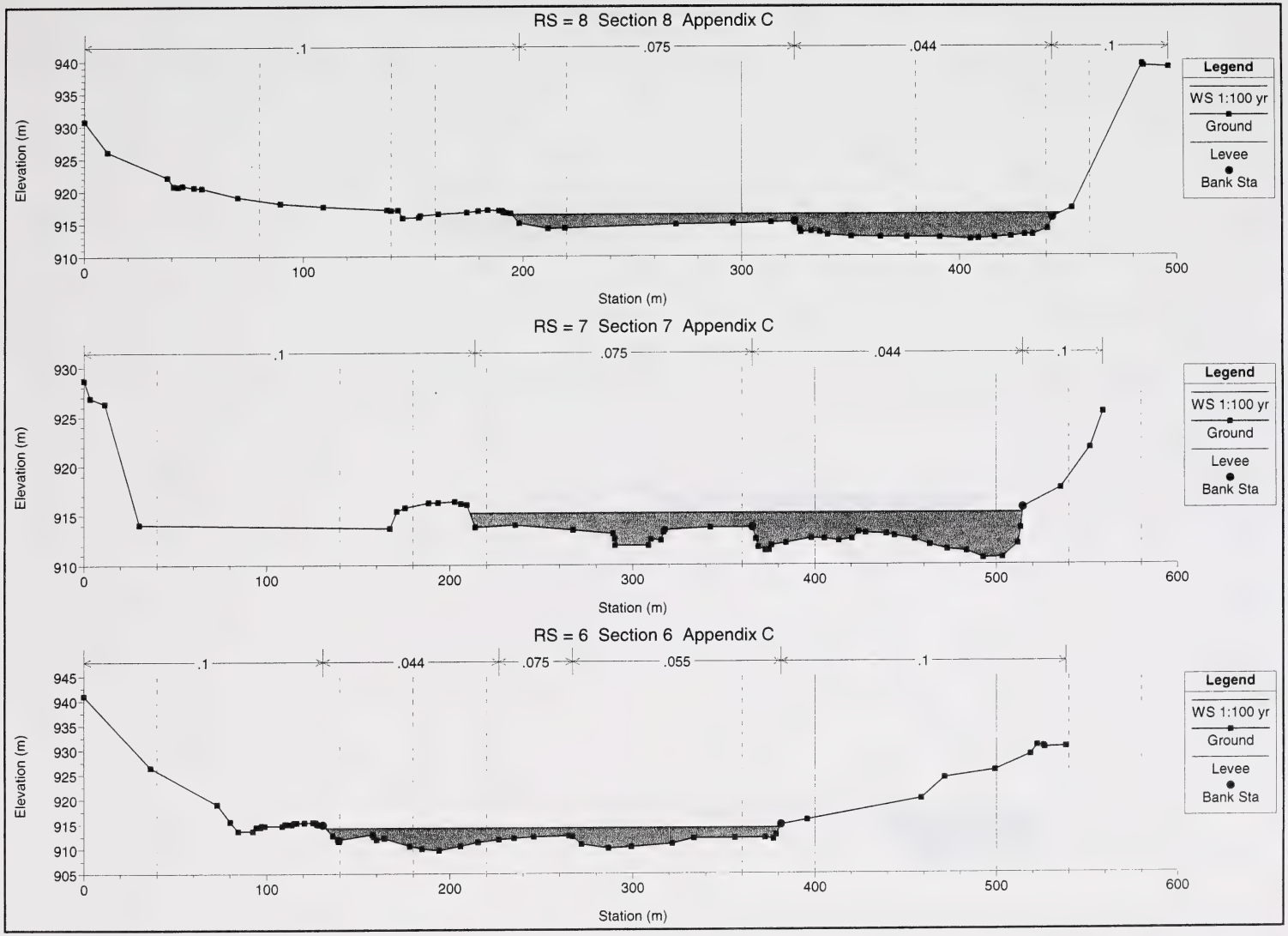
100
150
200
250
300
350
Station (m)
Legend
WS 1:100 yr
Ground
Bank Sta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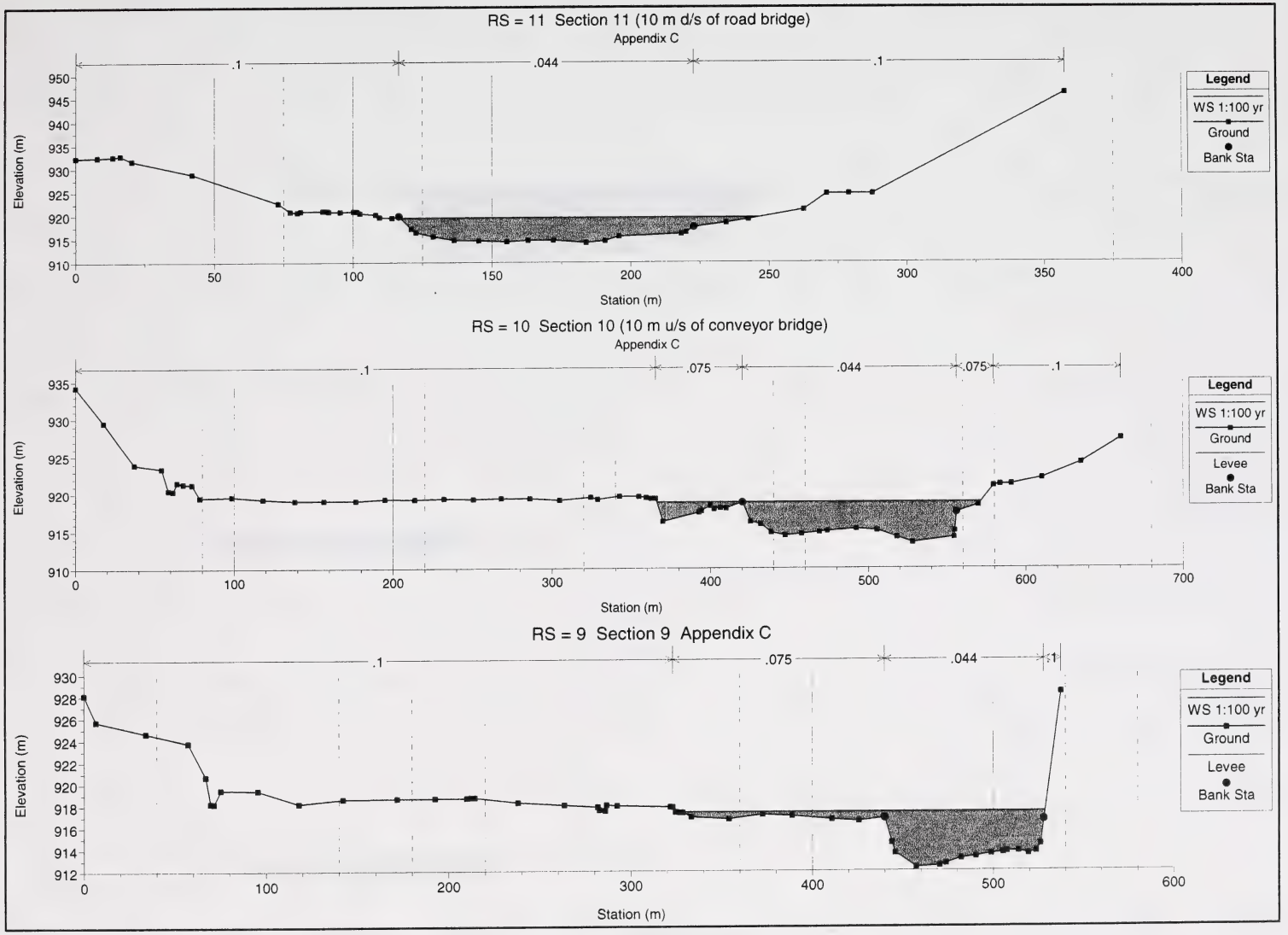
Elevation (m)
940
935
930
925
920
915
910
0
100
200
300
400
500
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 7 Section 7 Appendix C
.1
.075
.044
.1
Elevation (m)
930
925
920
915
910
0
100
200
300
400
500
600
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 6 Section 6 Appendix C
.1
.044
.075
.055
.1
Elevation (m)
945
940
935
930
925
920
915
910
905
0
100
200
300
400
500
600
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta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Appendix C
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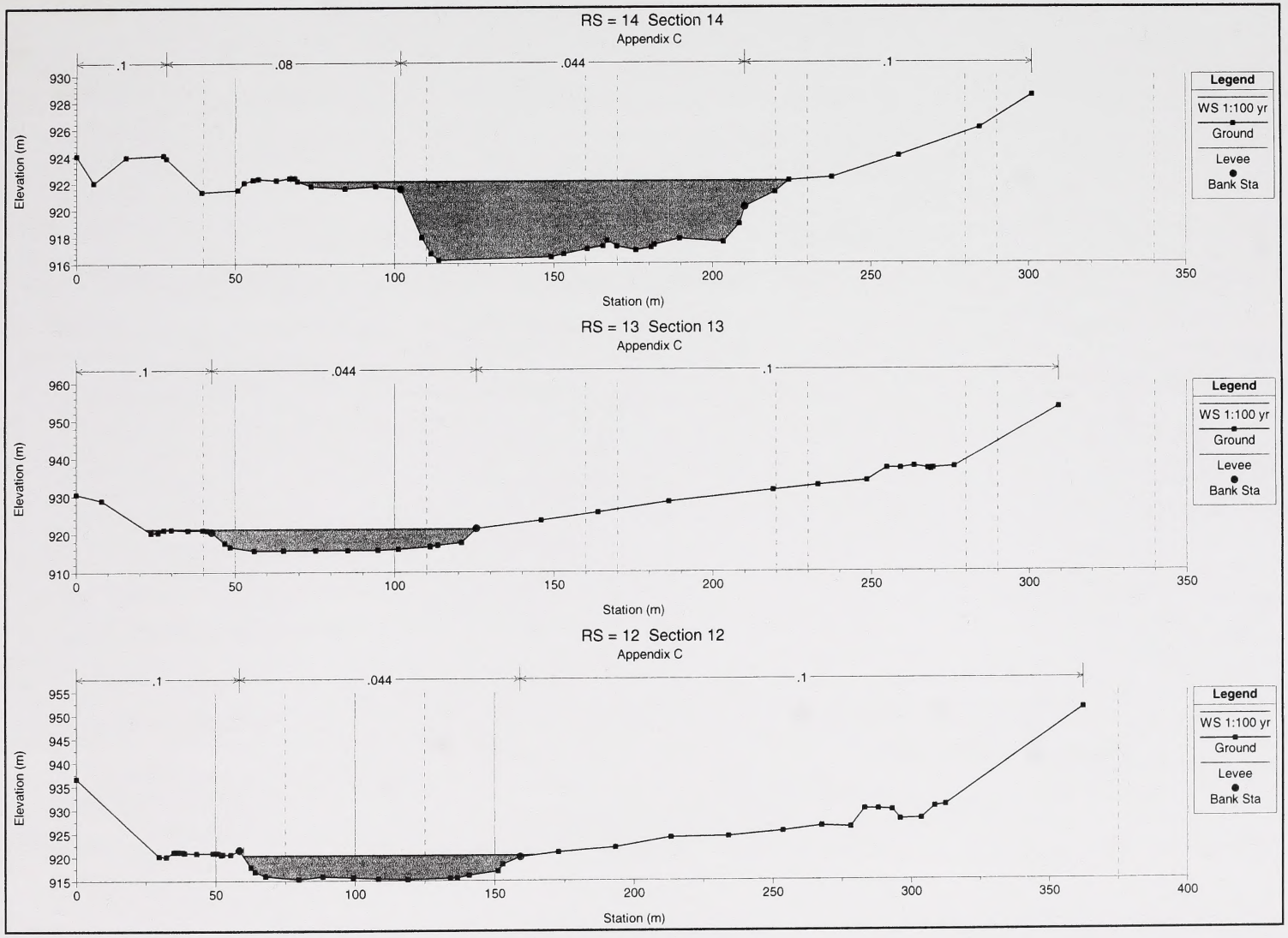
Elevation (m)
950
945
940
935
930
925
920
915
910
0
50
100
150
200
250
300
350
400
Station (m)
Legend
WS 1:100 yr
Ground
Bank Sta
RS = 10 Section 10 (10 m u/s of conveyor bridge)
Appendix C
.1
.075
.044
.075
.1
Elevation (m)
935
930
925
920
915
910
0
100
200
300
400
500
600
700
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 9 Section 9 Appendix C
.1
.075
.044
.1
Elevation (m)
930
928
926
924
922
920
918
916
914
912
0
100
200
300
400
500
600
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta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Appendix C
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.08
.044
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Elevation (m)
930
928
926
924
922
920
918
916
0
50
100
150
200
250
300
350
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 13 Section 13
Appendix C
.1
.044
.1
Elevation (m)
960
950
940
930
920
910
0
50
100
150
200
250
300
350
Station (m)
Legend
WS 1:100 yr
Ground
Levee
Bank Sta
RS = 12 Section 12
Appendix C
.1
.044
.1
Elevation (m)
955
950
945
940
935
930
925
920
915
0
50
100
150
200
250
300
350
400
Station (m)
Legend
WS 1:100 yr
Ground
Levee
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